Ontario Hydro

1/2

PREDICTION OF LONG-TERM RELEASES OF ^{134}Cs FROM CEMENTED DECONTAMINATION WASTES BY SEMI-INFINITE DIFFUSION MODELS

ort No 84-209-K

M.A. Habayeb
Chemist
Organic Section
Chemical Research Department

RESEARCH DIVISION

91602
new 82-10

COMPLIMENTARY COPY
Please Credit Ontario Hydro Research if
Reproduced in Whole or in Part.

ontario hydro
research division

PREDICTION OF LONG-TERM RELEASES OF ^{134}Cs FROM CEMENTED DECONTAMINATION WASTES BY SEMI-INFINITE DIFFUSION MODELS

Report No 84-209-K

M.A. Habayeb
Chemist
Organic Section
Chemical Research Department

ABSTRACT

Estimation of long-term radioactivity releases from cemented decontamination wastes is necessary to evaluate matrix effectiveness under disposal conditions. Semi-infinite solid diffusion models based on mass transport theory were investigated in this work to predict the total amount of radioactivity released into the environment at any time, t, using short term leaching data. The results show ^{134}Cs releases predicted by a model that accounts for instantaneous releases, diffusion processes and radioactive decay (Model 2A) are in good agreement with the experimental releases. The diffusion coefficients (cm^2/sec) and instantaneous releases (cm) estimated by this model varied with waste and matrix composition. In general, alkaline permanganate, peroxide bicarbonate and Turco 4521A exhibited lower diffusion coefficients and radioactivity releases than Turco 4512 and potassium persulfate wastes. Depending on waste composition, diffusion coefficients for Portland Type 30 cement/bentonite waste forms were in the order of 10^{-8} to 10^{-11} cm^2/sec whereas those for plain Portland Type 30 cement and Portland Type 30 cement/silicate waste products ranged from 10^{-7} to 10^{-9} cm^2/sec. Additionally, Portland Type 30 cement/bentonite waste forms exhibited least deviation from semi-infinite behaviour. Application of Model 2A to the

job	file	date	report no.
740632-537-062	837.83	August 28, 1984	84-209-K

experimental leaching data reveals that only alkaline permanganate and peroxide bicarbonate wastes solidified with Portland Type 30 cement/bentonite matrix can be expected to retain more than 60% of the original activity after twenty years leaching. The excellent agreement between the experimental and predicted releases indicates the leaching behaviour of the waste forms is controlled by non-diffusion processes such as rapid wash-off of the immersed surfaces during the early stages of the leach test and by diffusion processes at long leaching time. When the leaching period exceeds several half-lives, radioactive decay assumed more importance than leaching.

Because of the large number of Appendices, this report has been issued in two parts. The first part comprises the main body of the report. The second part issued as Addendum to 84-209-K, contains all Appendices (1 through 11) and will be provided on request.

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
2.0	EXPERIMENTAL DETAILS	2
3.0	SEMI-INFINITE SOLID DIFFUSION MODELS	2
	3.1 Model 1 (No Radioactive Decay Correction)	2
	3.2 Model 1A (Corrected for Radioactive Decay)	3
	3.3 Model 2 (No Radioactive Decay Correction)	3
	3.4 Model 2A (Corrected for Radioactive Decay)	4
	3.5 Model 3 (No Radioactive Decay Correction)	4
	3.6 Calculation of Diffusion Coefficients and Long-Term Releases	4
4.0	RESULTS	4
5.0	DISCUSSION	
	5.1 Application of Models 1 and 1A to Leaching Data	4
	5.2 Estimation of Long-Term Releases by Models 1 and 1A	7
	5.3 Application of Model 2 to Leaching Data	
	5.3.1 Diffusion Coefficients and Instantaneous Releases	8
	5.3.2 Prediction of Long-Term ^{134}Cs Releases	12
	5.4 Application of Model 3 to Leaching Data	12
6.0	DEVIATION FROM SEMI-INFINITE BEHAVIOUR	18
7.0	PROPOSED LEACHING MECHANISM	18
8.0	CONCLUSIONS	20
9.0	FUTURE WORK	21
REFERENCES		22
APPENDICES		23
DISTRIBUTION		last page

LIST OF TABLES

Table No		Page
1	EFFECT OF WASTE AND MATRIX COMPOSITIONS AND RADIOACTIVE DECAY ON DIFFUSION COEFFICIENTS PREDICTED BY MODEL 1 WITH AND WITHOUT RADIOACTIVE DECAY	5
2	CUMULATIVE FRACTIONAL AND PERCENTAGE CUMULATIVE RELEASES PREDICTED BY MODEL 1 WITH AND WITHOUT RADIOACTIVE DECAY CORRECTION	9
3	DIFFUSION COEFFICIENTS AND INSTANTANEOUS RELEASES (Y-INTERCEPT) PREDICTED BY MODEL 2	10
4	CUMULATIVE FRACTIONAL AND PERCENTAGE CUMULATIVE RELEASES PREDICTED BY MODEL 2A	13
5	DIFFUSION COEFFICIENTS AND INSTANTANEOUS RELEASES (Y-INTERCEPT) PREDICTED BY MODEL 3	15
6	CUMULATIVE FRACTIONAL AND PERCENTAGE CUMULATIVE RELEASES PREDICTED BY MODEL 3 (PHASE 2)	16
7	PERCENTAGE CUMULATIVE RELEASES PREDICTED BY MODEL 3 WITH AND WITHOUT THE FIRST FOUR DAYS LEACHING DATA	17
8	VARIATIONS OF DEPARTURE FROM THE SEMI-INFINITE BEHAVIOUR (Z) WITH WASTE COMPOSITION AND TYPE OF MATRIX	19

LIST OF FIGURES

Figure No		Page
1	EFFECT OF WASTE AND MATRIX COMPOSITIONS AND RADIOACTIVE DECAY ON DIFFUSION COEFFICIENTS PREDICTED BY MODEL 1	6
2	EFFECT OF WASTE AND MATRIX COMPOSITIONS AND RADIOACTIVE DECAY ON DIFFUSION COEFFICIENTS PREDICTED BY MODEL 2	11

ontario hydro
research division

To Mr. F.J. Kee
Director of Research

PREDICTION OF LONG-TERM RELEASES OF ^{134}Cs FROM CEMENTED DECONTAMINATION WASTES BY SEMI-INFINITE DIFFUSION MODELS

1.0 INTRODUCTION

Short-term releases of ^{134}Cs from decontamination wastes solidified with plain Portland Type 30 cement (PC-30), PC-30/bentonite and PC-30/silicate matrices have been reported in Research Report No 83-320-K. To assess the effectiveness of these matrices under disposal conditions, it is necessary to estimate radioactivity releases from the waste forms into the environment at times much longer than the leach test. A literature survey on long-term leachability of solid wastes revealed a large number of investigations has been published/1-5/. In these studies statistical methods and mathematical models based on mass transport theory were used to predict the total amount of radioactivity released at any time/5/.

Application of statistical methods to experimental leaching data involves fitting the data to linear and non-linear regression functions followed by extrapolation of the results. This analysis can be used to fit leaching data which deviate from mass transport behaviour/1/.

Mass transport models reported in the literature include finite solid diffusion models, infinite solid diffusion models and semi-infinite solid diffusion models. Of these types, semi-infinite solid diffusion models are most commonly used to describe the leaching performance of waste forms. The diffusion models are in agreement with Fick's Law of diffusion which states the flux of a diffusing species through a unit area of a plane perpendicular to the direction of the flow in unit time is proportional to concentration gradient/5-7/. Mathematical representations of the semi-infinite diffusion models investigated in this work are given in Section 3.0 of this report.

This report discusses the prediction of long-term radioactivity releases from cemented decontamination wastes by semi-infinite solid diffusion models, fits the experimental leaching data to

these models, identifies models that best fit the data and proposes a leaching mechanism to describe radionuclide releases from the waste forms. The effects of waste and matrix compositions and radioactive decay on long-term releases are also discussed.

2.0 EXPERIMENTAL DETAILS

The simulated decontamination wastes investigated in this work were labelled with ^{134}Cs (average activity of 304 nCi/mL waste) and ^{60}Co (average activity of 752 nCi/mL waste); treated by chemical precipitation as proposed in Reference 8, and then solidified with PC-30, PC-30/bentonite and PC-30/silicate matrices. The average waste-to-matrix ratio was 0.42 for alkaline permanganate, Turco 4521A and peroxide bicarbonate; 0.61 for Turco 4512 and 0.72 for potassium persulfate. The cemented wastes were cured in sealed 5 cm right cylinder leaching cups for 32 days at 25±1°C. The waste forms were then leached by the International Atomic Energy Agency's (IAEA) static leach test method modified for whole body immersion in deionized water (350 mL)/9/. The leachant was replaced daily during the first four days, on the seventh day, weekly for the following three weeks, on the eightieth day and after one hundred and twenty days.

Radioactivity releases in the leachates were determined by γ-ray spectrometry using a Canberra multichannel analyzer fitted with a Ge(Li) detector (14% efficiency).

Experimental cumulative releases were calculated as recommended by the IAEA leach test method/9/. Leaching parameters were determined by a least square method using the Statistical Analysis Systems (SAS) package developed by the SAS Institute, Cary, North Carolina.

3.0 SEMI-INFINITE SOLID DIFFUSION MODELS

Three semi-infinite solid diffusion models were applied to the cumulative fractions of radionuclides released after 120 days leaching to predict long-term radioactivity releases. These models assumed no change in the leaching environment, the leached radionuclide was stable and its half-life ($t_{\frac{1}{2}}$) was longer than the leaching period. Furthermore, the models assumed the concentration of the radionuclide at the boundary between the leachant and the waste form was zero at any time during the leaching period/1,4,5/. The semi-infinite solid diffusion models are as follows.

3.1 Model 1 (No Radioactive Decay Correction)

$$\left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right] = 2\left(\frac{D}{\pi}\right)^{\frac{1}{2}} t^{\frac{1}{2}} \qquad [1]$$

where A_n = radioactivity released during n days in ηCi

A_o = initial radioactivity in the waste form, ηCi

V = volume of waste form, cm^3

S = exposed surface area, cm^2

D = diffusion coefficient , cm^2/sec

t = total leaching period, days.

According to this model, a plot of cumulative fractions released (cm) versus the square root of the total leaching period (SQRT) is expected to yield a straight line with zero intercept and a slope, m, equals $2(D/\pi)^{\frac{1}{2}}/1,4/$.

3.2 Model 1A (Corrected for Radioactive Decay)/4/

$$\left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right] = \sqrt{\frac{D}{\lambda}}\ \mathrm{erf}(\lambda t) \qquad [2]$$

where λ is a decay constant which equals $(\ell n 2/t_{\frac{1}{2}})$

$t_{\frac{1}{2}}$ = half-life of radionuclide of interest

erf u = error function = $\frac{2}{\sqrt{\pi}}\int_o^u e^{-z^2}\,dz$

The remaining terms have their usual meaning.

The derivation of Model 1A is given in Appendix 1.

3.3 Model 2 (No Radioactive Decay Correction)

$$\left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right] = \left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right]_o + 2\left(\frac{D}{\pi}\right)^{\frac{1}{2}} t^{\frac{1}{2}} \qquad [3]$$

This model is suited for waste forms that exhibit high releases during the early stages of the leach test, ie, deviate from Models 1 and 1A. According to Model 2, a plot of cumulative fractions released as a function of the square root of the total leaching period is expected to yield a non-zero intercept which equals $[(\Sigma A_n/A_o)(V/S)]_o$ and a slope equal to $2(D/\pi)^{\frac{1}{2}}$. The term $[(\Sigma A_n/A_o)(V/S)]_o$ represents non-diffusion processes such as instantaneous releases, chemical interactions between the leachant and the solid waste and solvolysis effects whereas the term $2(D/\pi)^{\frac{1}{2}}$ describes diffusion controlled processes which dominate during the later stages of leaching/1/.

3.4 Model 2A (Corrected for Radioactive Decay)

$$\left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right] = \left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right]_o + \sqrt{\frac{D}{\lambda}}\ \mathrm{erf}(\lambda t) \qquad [4]$$

The derivation of this model is given in Appendix 1. The main difference between Model 1A and Model 2A is the term $[(\Sigma A_n/A_o)(V/S)]_o$ which represents the instantaneous releases/4/.

3.5 Model 3 (No Radioactive Decay Correction)

Model 3 involves applying Model 2 to the leaching data during the first 4 days of leaching (phase 1) and the leaching data from 7 to 120 days (phase 2) separately/10/.

$$\left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right] = \left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right]_o + 2\left(\frac{D}{\pi}\right)^{1/2} t^{1/2} \qquad [5]$$

3.6 Calculation of Diffusion Coefficients and Long-Term Releases

The diffusion coefficients (D) were calculated by fitting the experimental leaching data to the various models to determine the slope and intercept. The slope of each fitted curve was equated to $2(D/\pi)^{1/2}$ and then the calculated D values were used in the models to predict long-term ^{134}Cs releases. In all cases, it was assumed that D values remained constant during the leaching period/1,4/.

4.0 RESULTS

The experimental leaching data used in this work were reported in Research Report 83-320-K/11/. The cumulative releases from alkaline permanganate (AP), Turco 4521A, Turco 4512 and potassium persulfate (PP) solutions solidified with plain PC-30, PC-30/bentonite and PC-30/silicate matrices were fitted to Models 1, 2 and 3 with and without radioactive decay correction. The experimental releases and those predicted by the models are tabulated in Appendices 2, 3, 6, 7 and 10 and plotted as a function of the square root of the total leaching period in Appendices 4, 5, 8, 9 and 11.

5.0 DISCUSSION

5.1 Application of Models 1 and 1A to Leaching Data

The diffusion coefficients calculated by Models 1 and 1A are compared in Table 1 and depicted in Figure 1. These data show the diffusion coefficients are sensitive to radioactive decay and

TABLE 1

EFFECT OF WASTE AND MATRIX COMPOSITIONS AND RADIOACTIVE DECAY ON DIFFUSION COEFFICIENTS PREDICTED BY MODEL 1 WITH AND WITHOUT RADIOACTIVE DECAY

Sample No	Waste	Matrix	D_1	D_2
1	Alkaline Permanganate	Portland Type 30 Cement	1.98E-08	1.78E-07
2	Alkaline Permanganate	PC-30 & Bentonite	7.36E-11	7.65E-10
3	Alkaline Permanganate	PC-30 & Silicate	3.78E-08	3.31E-07
4	Turco 4512	Portland Type 30 Cement	7.36E-08	6.88E-07
5	Turco 4512	PC-30 & Bentonite	7.80E-09	7.94E-08
6	Turco 4512	PC-30 & Silicate	6.90E-08	6.26E-07
7	Turco 4521A	Portland Type 30 Cement	2.36E-08	2.20E-07
8	Turco 4521A	PC-30 & Bentonite	6.52E-10	5.91E-09
9	Turco 4521A	PC-30 & Silicate	2.87E-08	2.74E-07
10	Peroxide Bicarbonate	Portland Type 30 Cement	2.19E-08	2.06E-07
11	Peroxide Bicarbonate	PC-30 & Bentonite	7.20E-11	7.45E-10
12	Peroxide Bicarbonate	PC-30 & Silicate	3.07E-08	2.89E-07
13	Potassium Persulfate	Portland Type 30 Cement	6.90E-08	6.43E-07
14	Potassium Persulfate	PC-30 & Bentonite	3.29E-09	3.23E-08
15	Potassium Persulfate	PC-30 & Silicate	7.14E-08	6.80E-07

D_1 No Radioactive Decay Correction (Model 1)

D_2 Corrected for Radioactive Decay (Model 1A)

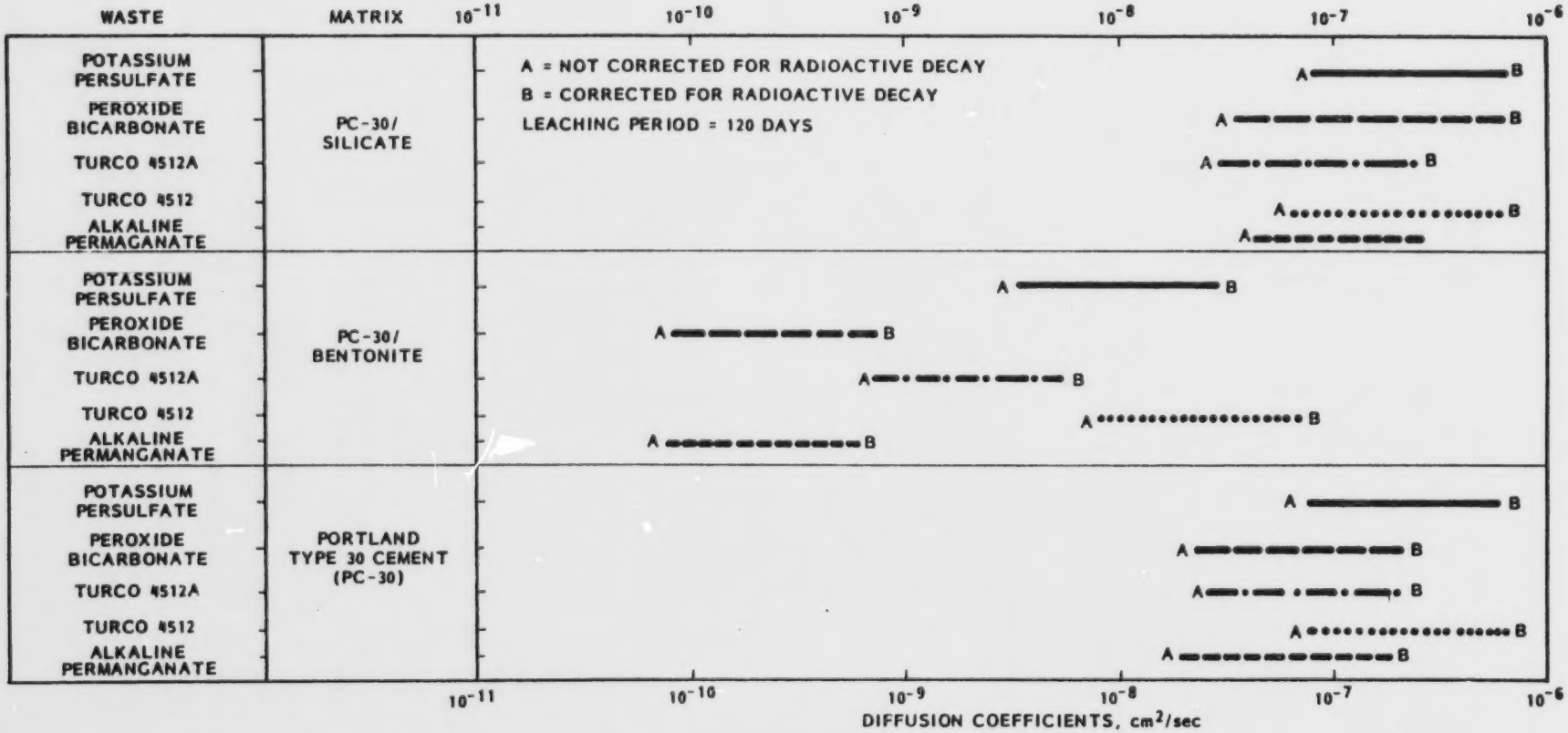


FIGURE 1

EFFECT OF WASTE AND MATRIX COMPOSITIONS AND RADIOACTIVE DECAY ON DIFFUSION COEFFICIENTS PREDICTED BY MODEL 1

waste and matrix compositions. Diffusion coefficients corrected for radioactive decay, D_2, were about one order of magnitude higher than those calculated by Model 1 without radioactive decay correction, D_1. This table shows, depending on waste composition, D_1 and D_2 values for PC-30/bentonite waste forms were about one to three orders of magnitude lower than D_1 and D_2 values for plain PC-30 and PC-30/silicate waste products. As an example, the D_1 value (calculated by Model 1) for a peroxide bicarbonate/PC-30 + bentonite waste form was about 7.2×10^{-11} cm^2/sec as compared with 2.19×10^{-6} cm^2/sec for plain PC-30 and 3.07×10^{-8} cm^2/sec for PC-30/silicate matrix. The corresponding D_2 values corrected for radioactive decay were 7.45×10^{-10}, 2.06×10^{-7} and 2.89×10^{-7} cm^2/sec, respectively. Similar trends were exhibited by other decontamination wastes. The low diffusion coefficients associated with the PC-30/bentonite matrix are probably due to the reduced water permeability and porosity of this matrix.

The effect of waste composition on diffusion coefficients D_1 and D_2 is exhibited in Figure 1. This figure shows in the case of plain PC-30 and PC-30/silicate matrices D_1 and D_2 varied only slightly with waste composition, whereas within PC-30/bentonite D_1 and D_2 values varied with waste composition as follows: peroxide bicarbonate < alkaline permanganate < Turco 4521A < potassium persulfate < Turco 4512. For example, wastes solidified with plain PC-30 and PC-30/silicate matrices exhibited D_1 values in the order of about 2.0×10^{-8} to 8.0×10^{-8} cm^2/sec whereas D values for wastes solidified with PC-30/bentonite ranged from 3.29×10^{-9} to 7.36×10^{-11} cm^2/sec (Table 1). Similar behaviour was observed for D_2 values.

5.2 Estimation of Long-Term Releases by Models 1 and 1A

Experimental ^{134}Cs releases and those predicted by Models 1 and 1A are tabulated in Appendices 2 and 3 and are also plotted as a function of the square root of the total leaching period in Appendices 4 and 5. The data in Appendices 2 (not corrected for radioactive decay) and 3 (corrected for radioactive decay) revealed that the releases predicted by Models 1 and 1A did not agree well with the experimental releases. In all cases, both models underestimated radioactivity releases during the early stages of the leach test and exaggerated the total radioactivity released during the final weeks of the leaching period. For example, actual releases from alkaline permanganate/PC-30 waste forms after one day leaching are 1.21×10^{-1} cm whereas those predicted by Models 1 and 1A are 4.66×10^{-2} cm and 4.27×10^{-3} cm respectively. As shown in Appendices 3 and 4, a plot of cumulative releases versus the square root of the total leaching period did not yield the straight line with zero intercept required by Models 1 and 1A. Deviation of the experimental releases from those predicted by the

models indicated these models failed to describe the leaching behaviour of the waste forms and that consideration of non-diffusion controlled processes may be required to fully explain the leachability of the waste products. These non-diffusion processes include instantaneous wash-off, solvent effects and reactions between the diffusing species and the waste form.

Table 2 summarizes cumulative fractions released (cm) and percentage cumulative releases, %, predicted by Models 1 and 1A at the end of 1-year, 5-years and 20-years leaching periods. In all cases the predicted releases corrected for radioactive decay are significantly higher than the predicted releases without radioactive decay. The reason for this is that the releases predicted by the model corrected for radioactive decay include the amount of radioactivity decayed during the immersion period whereas the releases predicted by Model 1 do not account for radioactive decay. In addition, the data in Table 2 show releases predicted by Model 1A approach an asymptote after 5 years. This signifies the importance of radioactive decay at long leaching times.

As shown in Table 2, wastes solidified with plain PC-30 and PC-30/silicate matrices may be expected to release all the radioactivity after one year leaching. Only wastes solidified with PC-30/bentonite should retain between 32 and 93% of the original activity depending on waste composition. After twenty years, however, only alkaline permanganate/PC-30/bentonite and peroxide bicarbonate/PC-30/bentonite waste forms might be expected to retain about 65 to 70% of the original activity.

5.3 Application of Model 2 to Leaching Data.

5.3.1 Diffusion Coefficients and Instantaneous Releases

The diffusion coefficients and the instantaneous releases from the various waste forms are given in Table 3. The effect of waste composition, type of matrix and radioactive decay on diffusion coefficients is shown in Figure 2. The data in Table 3 show, regardless of waste composition, instantaneous releases from PC-30/bentonite matrix were about one order to two orders of magnitude lower than the releases from plain PC-30 and PC-30/silicate matrices. This can be attributed to the superior water resistance of this matrix due to the ability of bentonite particles to fill the voids within the cement structure and to the homogeneity of the contaminated surfaces of the waste forms.

Within plain PC-30 and PC-30/bentonite matrices, initial releases varied with waste composition as follows: peroxide bicarbonate $\leq$ alkaline permanganate < Turco 5421A < potassium persulfate < Turco 4512. In the case of the PC-30/silicate matrix the initial releases varied with waste composition in the order of: Turco 4521A < peroxide bicarbonate < alkaline permanganate < potassium persulfate < Turco 4512. The high releases from potassium persulfate and Turco 4512 waste forms indicate heterogeneity and high solubility of the contaminated surfaces.

TABLE 2

CUMULATIVE FRACTIONAL AND PERCENTAGE CUMULATIVE RELEASES
PREDICTED BY MODEL 1 WITH AND WITHOUT RADIOACTIVE DECAY CORRECTION

Sample No	Waste	Matrix	1 Year				5 Years				20 Years			
			No Radioactive Decay Correction		Corrected for Radioactive Decay		No Radioactive Decay Correction		Corrected for Radioactive Decay		No Radioactive Decay Correction		Corrected for Radioactive Decay	
			Cumul Fraction Released (cm)	Cumul Releases (%)	Cumul Fraction Released (cm)	Cumul Releases (%)	Cumul Fraction Released (cm)	Cumul Releases (%)	Cumul Fraction Released (cm)	Cumul Releases (%)	Cumul Fraction Released (cm)	Cumul Releases (%)	Cumul Fraction Released (cm)	Cumul Releases (%)
1	Alkaline Permanganate	PC-30	8.91E-01	119	1.50E+00	201	1.99E+00	267	4.00E+00	536	3.99E+00	534	4.07E+00	545
2		PC-30/bentonite	5.44E-02	7	9.83E-02	13	1.22E-01	16	2.62E-01	34	2.43E-01	31	2.67E-01	34
3		PC-30/silicate	1.23E+00	157	2.04E+00	261	2.75E+00	351	4.45E+00	696	5.51E+00	703	5.54E+00	707
4	Turco 4512	PC-30	1.72E+00	211	2.95E+00	361	3.84E+00	471	7.86E+00	964	7.69E+00	942	7.49E+00	980
5	Turco 4512	PC-30/bentonite	5.60E-01	68	1.00E+00	121	1.25E+00	151	2.67E+00	323	2.50E+00	302	2.72E+00	328
6	Turco 4512	PC-30/silicate	1.66E+00	201	2.81E+00	340	3.72E+00	450	7.50E+00	906	7.44E+00	879	7.63E+00	921
7	Turco 4521A	PC-30	9.74E-01	133	1.67E+00	229	2.18E+00	299	4.45E+00	610	4.35E+00	597	4.52E+00	620
8	Turco 4521A	PC-30/bentonite	1.62E-01	21	2.73E-01	36	3.62E-01	47	7.29E-01	95	7.23E-01	94	7.41E-01	96
9	Turco 4521A	PC-30/silicate	1.07E+00	140	1.86E+00	242	2.40E+00	312	4.96E+00	645	4.80E+00	624	5.04E+00	656
10	Peroxide Bicarbonate	PC-30	9.37E-01	126	1.62E+00	217	2.10E+00	281	4.31E+00	577	4.19E+00	562	4.38E+00	587
11		PC-30/bentonite	5.38E-02	7	9.70E-02	13	1.20E-01	16	2.59E-01	34	2.41E-01	32	2.63E-01	34
12		PC-30/silicate	1.11E+00	144	1.91E+00	248	2.48E+00	323	5.09E+00	662	4.96E+00	645	5.18E+00	673
13	Potassium Persulfate	PC-30	1.66E+00	200	2.85E+00	342	3.72E+00	446	7.60E+00	912	7.44E+00	893	7.73E+00	927
14		PC-30/bentonite	3.64E-01	43	6.39E-01	75	8.13E-01	96	1.70E+00	201	1.63E+00	191	1.73E+00	204
15		PC-30/silicate	1.69E+00	198	2.93E+00	343	3.79E+00	443	7.81E+00	915	7.57E+00	886	7.94E+00	930

PC: Portland Type 30 Cement
Cumul: Cumulative

TABLE 3

DIFFUSION COEFFICIENTS AND INSTANTANEOUS RELEASES
(Y-INTERCEPT) PREDICTED BY MODEL 2

Sample No	Waste	Matrix	No Correction for Radioactive Decay		Corrected for Radioactive Decay	
			Y-Intercep	D_3	Y-Intercep	D_4
1	Alkaline Permanganate	Portland Type 30 Cement	1.58E-01	4.74E-09	2.08E-01	2.65E-08
2	Alkaline Permanganate	PC-30 & Bentonite	4.83E-03	4.07E-11	9.21E-03	2.62E-10
3	Alkaline Permanganate	PC-30 & Silicate	2.45E-01	6.84E-09	3.06E-01	3.73E-08
4	Turco 4512	Portland Type 30 Cement	2.73E-01	2.16E-08	3.78E-01	1.28E-07
5	Turco 4512	PC-30 & Bentonite	5.55E-02	3.97E-09	9.93E-02	2.50E-08
6	Turco 4512	PC-30 & Silicate	3.09E-01	1.48E-08	3.96E-01	8.88E-08
7	Turco 4521A	Portland Type 30 Cement	1.63E-01	6.33E-09	2.19E-01	3.84E-08
8	Turco 4521A	PC-30 & Bentonite	3.24E-02	1.16E-10	3.98E-02	7.44E-10
9	Turco 4521A	PC-30 & Silicate	1.61E-01	9.26E-09	2.28E-01	5.69E-08
10	Peroxide Bicarbonate	Portland Type 30 Cement	1.44E-01	6.75E-09	2.02E-01	4.09E-08
11	Peroxide Bicarbonate	PC-30 & Bentonite	4.80E-03	3.97E-11	9.15E-03	2.52E-10
12	Peroxide Bicarbonate	PC-30 & Silicate	1.75E-01	9.10E-09	2.43E-01	5.52E-08
13	Potassium Persulfate	Portland Type 30 Cement	2.68E-01	1.98E-08	3.68E-01	1.18E-07
14	Potassium Persulfate	PC-30 & Bentonite	4.53E-02	1.35E-09	7.11E-02	8.32E-09
15	Potassium Persulfate	PC-30 & Silicate	2.57E-01	2.25E-08	3.63E-01	1.39E-07

PC-30: Portland Type 30 Cement

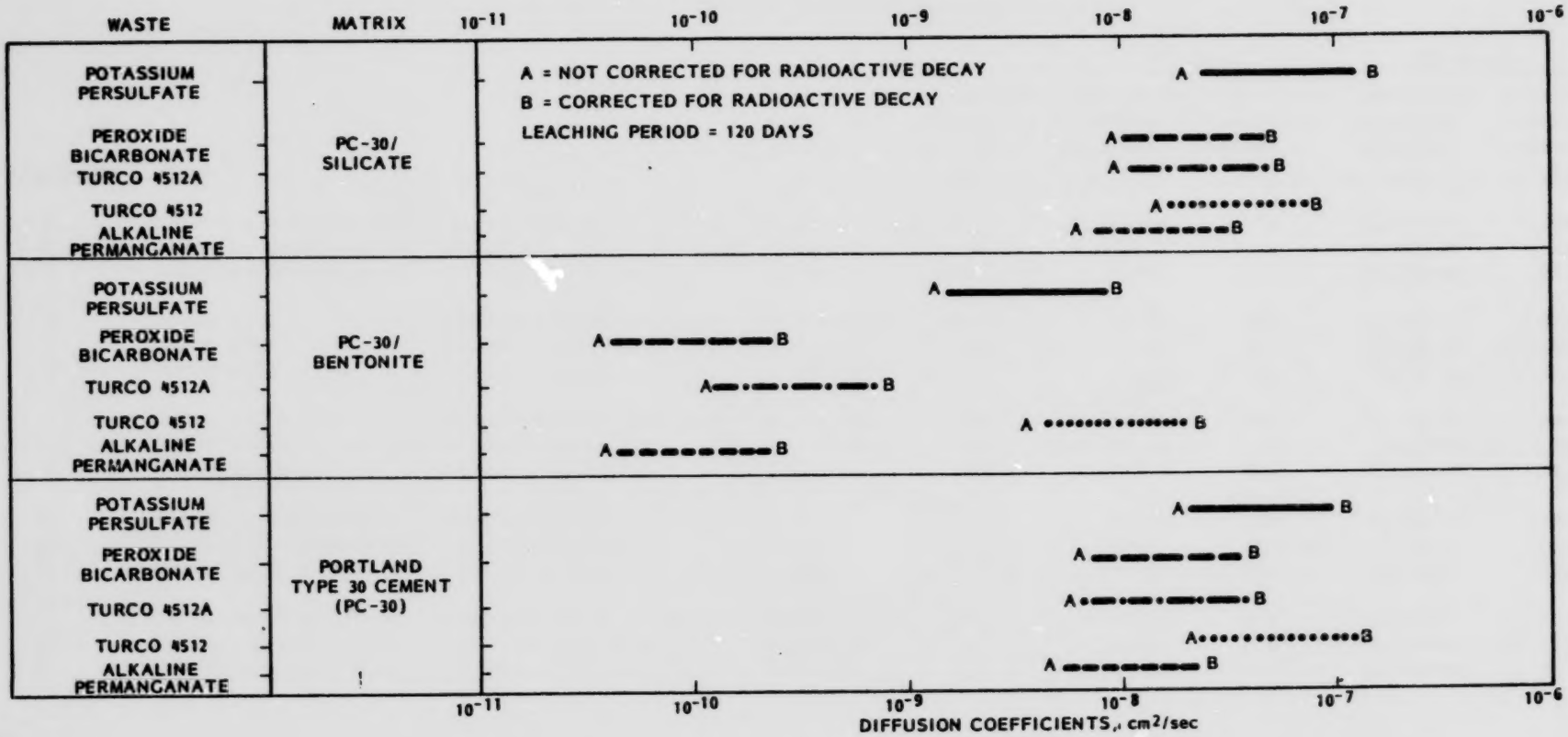


FIGURE 2

EFFECT OF WASTE AND MATRIX COMPOSITIONS AND RADIOACTIVE DECAY ON DIFFUSION COEFFICIENTS PREDICTED BY MODEL 2

200293 RD 84-209

The data in Figure 2 show diffusion coefficients were influenced by waste and matrix composition and radioactive decay. Variations of diffusion coefficients with these factors were similar to those observed for the instantaneous releases. In all cases diffusion coefficients with and without radioactive decay correction, D_4 and D_3, were lowest for the PC-30/bentonite matrix. Depending on waste composition, D_4 values for this matrix were in the order of 10^{-8} to 10^{-10} cm^2/sec whereas those for plain PC-30 and PC-30/silicate ranged from about 10^{-7} to 10^{-8} cm^2/sec. In general, D_3 and D_4 values varied with waste composition as follows: alkaline permanganate ∿ peroxide bicarbonate < Turco 4521A < Turco 4512 < potassium persulfate.

5.3.2 Prediction of Long-Term ^{134}Cs Releases

Appendices 6 and 7 compare the experimental releases with those predicted by Models 2 and 2A. The predicted and the experimental releases were also plotted as a function of the square root of the total leaching period in Appendices 8 and 9. These Appendices show releases predicted by Models 2 and 2A were in good agreement with the experimental leaching data particularly after the first four days of leaching. During these four days, the predicted releases were slightly higher than the experimental releases. During the period from 7 to 120 days, the residual releases (difference between experimental and predicted releases) decreased with time (Appendices 8 and 9). The agreement between the experimental and predicted releases indicate Model 2 or Model 2A can be used to describe the long-term leachability of the waste forms. However, because Model 2A accounts for radioactive decay of ^{134}Cs, it is expected to provide a more realistic description of the leaching behaviour of the waste forms. The releases predicted by Model 2A at 1 year, 5 years and 20 years are summarized in Table 4. This table shows the cumulative releases from all waste forms approached an asymptote after seven years leaching. As an example, the predicted cumulative fraction leached from alkaline permanganate /PC-30/bentonite waste form increased from 6.67×10^{-2} cm at 1 year to 1.65×10^{-1} cm at 5 years and 20 years (Appendix 7). This behaviour implies that radioactive decay is more important than leaching at long leaching time.

According to the data in Table 4 only alkaline permanganate, Turco 4521A and peroxide bicarbonate wastes solidified with PC-30/bentonite matrix could be expected to retain about 60 to 80% of the original activity after 20 years leaching depending on waste composition.

5.4 Application of Model 3 to Leaching Data

As shown in Appendices 10 and 11 a plot of experimental cumulative releases versus the square root of the total leaching period is not linear throughout the entire leaching period. Examination of these plots indicates that the leachability of the waste forms can

TABLE 4

CUMULATIVE FRACTIONAL AND PERCENTAGE CUMULATIVE RELEASES
PREDICTED BY MODEL 2A

Sample No	Waste	Matrix	1 Year		5 Years		20 Years	
			Cumulative Fraction Released (cm)	Percentage Cumulative Releases (%)	Cumulative Fraction Released (cm)	Percentage Cumulative Releases (%)	Cumulative Fraction Released (cm)	Percentage Cumulative Releases (%)
1	Alkaline Permanganate	Portland Type 30 Cement	7.87E-01	105	1.75E+00	235	1.78E+00	238
2	Alkaline Permanganate	PC-30 & Bentonite	6.67E-02	9	1.65E-01	21	1.65E-01	21
3	Alkaline Permanganate	PC-30 & Silicate	9.91E-01	127	2.14E+00	273	2.17E+00	277
4	Turco 4512	Portland Type 30 Cement	1.65E+00	202	3.77E+00	463	3.83E+00	470
5	Turco 4512	PC-30 & Bentonite	6.61E-01	80	1.60E+00	193	1.62E+00	196
6	Turco 4512	PC-30 & Silicate	1.46E+00	176	3.22E+00	389	3.27E+00	395
7	Turco 4521A	Portland Type 30 Cement	9.16E-01	126	2.08E+00	285	2.11E+00	289
8	Turco 4521A	PC-30 & Bentonite	1.37E-01	18	2.98E-01	39	3.03E-01	39
9	Turco 4521A	PC-30 & Silicate	1.08E+00	140	2.49E+00	324	2.53E+00	329
10	Peroxide Bicarbonate	Portland Type 30 Cement	9.21E-01	124	2.12E+00	284	2.15E+00	288
11	Peroxide Bicarbonate	PC-30 & Bentonite	6.56E-02	9	1.60E-01	21	1.62E-01	21
12	Peroxide Bicarbonate	PC-30 & Silicate	1.08E+00	140	2.47E+00	321	2.51E+00	326
13	Potassium Persulfate	Portland Type 30 Cement	1.59E+00	191	3.62E+00	434	3.67E+00	441
14	Potassium Persulfate	PC-30 & Bentonite	3.95E-01	47	9.36E-01	110	9.50E-01	112
15	Potassium Persulfate	PC-30 & Silicate	1.69E+00	197	3.89E+00	456	3.95E+00	462

be considered as taking place in two phases; phase 1 covering the first four days of leaching and phase 2 covering the period between 7 and 120 days. Initial releases (cm) and diffusion coefficients (cm^2/sec) during each phase can be estimated by applying Model 3 to the experimental leaching data. The initial releases and diffusion coefficients calculated by this procedure are given in Table 5. This table shows the initial releases estimated by using the data in phase 1 were about one order of magnitude lower than those calculated for phase 2 data.

The diffusion coefficients during the first four days of leaching were higher than the diffusion coefficients during the leaching period from 7 to 120 days. This indicates during the early stages of the leach test, non-diffusion processes such as dissolution of the contaminated surfaces may contribute significantly to the leachability of waste forms. An important feature of Table 5 is that initial releases (phase 1) from alkaline permanganate, Turco 4512 and peroxide bicarbonate solidified with PC-30/bentonite have a negative sign. This implies radioactivity releases from these waste forms are not instantaneous. The delay in radioactivity releases is probably due to water absorption by the bentonite crystals which is then followed by diffusion and exchange reactions. In this work, the time lag is estimated at about one to two hours depending on waste composition (Appendix 11). Furthermore, the data in Table 5 show diffusion coefficients and instantaneous releases were influenced by waste composition and type of matrix. As an example, D values for PC-30/bentonite waste forms ranged from 2.58×10^{-8} to 5.43×10^{-10} cm^2/sec whereas D values for plain PC-30 and PC-30/silicate matrices were in the order of 1.50×10^{-7} to 6.4×10^{-8} cm^2/sec depending on waste composition. Within each matrix, D values for alkaline permanganate, Turco 4521A and peroxide bicarbonate were lower than those observed for potassium persulfate and Turco 4512.

Appendix 10 compares the experimental releases with those predicted by applying Model 3 to the data in phase 1 and phase 2. These releases were also plotted as a function of the square root of the total leaching period as shown in Appendix 11. Within each phase, the data in Appendices 10 and 11 show the releases predicted by Model 3 (phases 1 and 2) are in excellent agreement with the experimental releases. The predicted releases at 1 year, 5 years and 20 years leaching periods are shown in Table 6. According to the data in this table, only alkaline permanganate, Turco 4521A and peroxide bicarbonate solidified with PC-30/bentonite might be expected to retain between 65 to 80% of the original activity after 20 years leaching.

Table 7 compares percentage cumulative releases predicted by Model 3 with and without using the leaching data obtained during the first four days of leaching. This table shows releases predicted

TABLE 5

DIFFUSION COEFFICIENTS AND INSTANTANEOUS RELEASES
(Y-INTERCEPT) PREDICTED BY MODEL 3

Sample No	Waste	Matrix	Phase 1 Leaching Period 0 - 4 Days		Phase 2 Leaching Period 7 - 120 Days	
			Intercep	D	Intercep	D
1	Alkaline Permanganate	Portland Type 30 Cement	4.19E-02	5.68E-08	2.42E-01	1.34E-09
2	Alkaline Permanganate	PC-30 & Bentonite	-5.48E-04	2.10E-10	8.41E-03	2.50E-11
3	Alkaline Permanganate	PC-30 & Silicate	5.24E-02	1.49E-07	3.55E-01	1.61E-09
4	Turco 4512	Portland Type 30 Cement	6.31E-02	2.20E-07	4.06E-01	9.16E-09
5	Turco 4512	PC-30 & Bentonite	-8.46E-03	2.58E-08	9.68E-02	2.22E-09
6	Turco 4512	PC-30 & Silicate	9.89E-02	2.13E-07	4.18E-01	6.34E-09
7	Turco 4521A	Portland Type 30 Cement	4.51E-02	7.08E-08	2.29E-01	2.93E-09
8	Turco 4521A	PC-30 & Bentonite	2.40E-02	5.43E-10	3.83E-02	7.25E-11
9	Turco 4521A	PC-30 & Silicate	3.31E-02	8.82E-08	2.35E-01	4.58E-09
10	Peroxide Bicarbonate	Portland Type 30 Cement	3.30E-02	6.42E-08	2.14E-01	3.07E-09
11	Peroxide Bicarbonate	PC-30 & Bentonite	-9.14E-04	2.21E-10	8.68E-03	2.31E-11
12	Peroxide Bicarbonate	PC-30 & Silicate	3.53E-02	9.98E-08	2.55E-01	4.17E-09
13	Potassium Persulfate	Portland Type 30 Cement	4.42E-02	2.43E-07	3.97E-01	8.24E-09
14	Potassium Persulfate	PC-30 & Bentonite	6.47E-03	8.81E-09	7.32E-02	6.76E-10
15	Potassium Persulfate	PC-30 & Silicate	5.08E-02	2.30E-07	3.70E-01	1.13E-08

TABLE 6

CUMULATIVE FRACTIONAL AND PERCENTAGE CUMULATIVE RELEASES
PREDICTED BY MODEL 3 (PHASE 2)

Sample No	Waste	Matrix	1 Year		5 Years		20 Years	
			Cumulative Fraction Released (cm)	Percentage Cumulative Releases (%)	Cumulative Fraction Released (cm)	Percentage Cumulative Releases (%)	Cumulative Fraction Released (cm)	Percentage Cumulative Releases (%)
1	Alkaline Permanganate	Portland Type 30 Cement	4.73E-01	63	7.60E-01	102	1.28E+00	171
2	Alkaline Permanganate	PC-30 & Bentonite	4.01E-02	5	7.93E-02	10	1.50E-01	19
3	Alkaline Permanganate	PC-30 & Silicate	6.10E-01	78	9.24E-01	118	1.49E+01	191
4	Turco 4512	Portland Type 30 Cement	1.01E+00	124	1.76E+00	216	3.12E+00	382
5	Turco 4512	PC-30 & Bentonite	3.96E-01	48	7.65E-01	92	1.43E+00	173
6	Turco 4512	PC-30 & Silicate	9.23E-01	111	1.55E+00	187	2.67E+00	323
7	Turco 4521A	Portland Type 30 Cement	5.72E-01	78	9.95E-01	136	1.76E+00	242
8	Turco 4521A	PC-30 & Bentonite	9.22E-02	12	1.59E-01	21	2.80E-01	36
9	Turco 4521A	PC-30 & Silicate	6.64E-01	86	1.19E+00	155	2.15E+00	280
10	Peroxide Bicarbonate	Portland Type 30 Cement	5.65E-01	76	9.98E-01	134	1.78E+00	239
11	Peroxide Bicarbonate	PC-30 & Bentonite	3.92E-02	5	7.68E-02	10	1.45E-01	19
12	Peroxide Bicarbonate	PC-30 & Silicate	6.64E-01	86	1.17E+00	152	2.08E+00	271
13	Potassium Persulfate	Portland Type 30 Cement	9.72E-01	117	1.68E+00	202	2.97E+00	356
14	Potassium Persulfate	PC-30 & Bentonite	2.38E-01	28	4.42E-01	52	8.10E-01	95
15	Potassium Persulfate	PC-30 & Silicate	1.04E+00	122	1.88E+00	220	3.38E+00	396

TABLE 7

PERCENTAGE CUMULATIVE RELEASES
PREDICTED BY MODEL 3 WITH AND WITHOUT THE
FIRST FOUR DAYS LEACHING DATA

Sample No	Waste	Matrix	1 Year		5 Years		20 Years	
			Leaching Data 1 - 120 Days	7 - 120 Days	Leaching Data 1 - 120 Days	7 - 120 Days	Leaching Data 1 - 120 Days	7 - 120 Days
1	Alkaline Permanganate	Portland Type 30 Cement	80	63	155	102	283	171
2	Alkaline Permanganate	PC-30 & Bentonite	6	5	12	10	24	19
3	Alkaline Permanganate	PC-30 & Silicate	98	78	181	118	330	191
4	Turco 4512	Portland Type 30 Cement	148	124	289	216	544	382
5	Turco 4512	PC-30 & Bentonite	55	48	115	92	220	173
6	Turco 4512	PC-30 & Silicate	131	111	246	187	454	323
7	Turco 4521A	Portland Type 30 Cement	91	78	177	136	332	242
8	Turco 4521A	PC-30 & Bentonite	13	12	24	21	44	36
9	Turco 4521A	PC-30 & Silicate	100	86	198	155	375	280
10	Peroxide Bicarbonate	Portland Type 30 Cement	89	76	175	134	331	239
11	Peroxide Bicarbonate	PC-30 & Bentonite	6	5	12	10	24	19
12	Peroxide Bicarbonate	PC-30 & Silicate	101	86	198	152	374	271
13	Potassium Persulfate	Portland Type 30 Cement	139	117	271	202	510	356
14	Potassium Persulfate	PC-30 & Bentonite	33	28	67	52	128	95
15	Potassium Persulfate	PC-30 & Silicate	141	122	279	220	528	396

by applying Model 3 to the experimental releases obtained during the entire leaching period were not significantly different from those predicted by using the leaching data obtained during the leaching period 7 to 120 days. This reveals no additional improvement in the fit between experimental and predicted releases was obtained by dividing the leaching process into two discrete phases.

6.0 DEVIATION FROM SEMI-INFINITE BEHAVIOUR

Model 2A corrected for radioactive decay can be used to predict long-term leachability of the waste forms because the experimental releases and those predicted by the model were in good agreement. In all cases, residuals (experimental releases - predicted releases) were probably due to deviation from the semi-infinite behaviour required by Model 2. The departure from a semi-infinite behaviour (Z) for a cylindrical geometry can be estimated if the radius of the cylinder (R), leaching period (t) and the diffusion coefficients are known. Assuming the leaching mechanism is diffusion controlled particularly at long leaching time, Z values for long and finite cylinders can be calculated using equations 6 and 7/12/.

For long cylinder:

$$Z \simeq \frac{(\pi Dt)^{\frac{1}{2}}}{2R} \qquad [6]$$

and for a finite cylinder

$$Z \simeq \left(\frac{1}{2\pi}\right)\left(\frac{\pi H+16R}{H+R}\right)\frac{(\pi Dt)^{\frac{1}{2}}}{2R} \qquad [7]$$

Table 8 summarizes Z values for the waste forms. The data in this table indicate the waste forms can be approximated by long to finite cylinders. Furthermore, regardless of waste composition, PC-30/bentonite waste forms exhibited lowest Z values, ie, behaved as semi-infinite media. Within each of the matrices investigated, Z values for alkaline permanganate, Turco 4521A and peroxide bicarbonate were lower than those observed for Turco 4512 and potassium persulfate. This shows that waste forms containing insoluble species deviated less from semi-infinite behaviour than those containing soluble species/8/.

7.0 PROPOSED LEACHING MECHANISM

The excellent agreement between the experimental releases and those predicted by Model 2A (corrected for radioactive decay) indicates the leaching behaviour of the waste forms can be described by non-diffusion and diffusion controlled processes. During the first four days of leaching, the data show non-diffusion,

TABLE 8

VARIATIONS OF DEPARTURE FROM THE SEMI-INFINITE BEHAVIOUR (Z) WITH WASTE COMPOSITION AND TYPE OF MATRIX

Sample No	Waste	Matrix	Diffusion Coefficients[1]	Z for a Long Cylinder[2]	Z for a Finite Cylinder[2]
1	Alkaline Permanganate	Portland Type 30 Cement	2.65E-08	0.19	0.22
2	Alkaline Permanganate	PC-30 & Bentonite	2.62E-10	0.02	0.02
3	Alkaline Permanganate	PC-30 & Silicate	3.73E-8	0.22	0.26
4	Turco 4512	Portland Type 30 Cement	1.28E-7	0.41	0.48
5	Turco 4512	PC-30 & Bentonite	2.50E-8	0.18	0.21
6	Turco 4512	PC-30 & Silicate	8.88E-8	0.34	0.40
7	Turco 4521A	Portland Type 30 Cement	3.84E-8	0.22	0.26
8	Turco 4521A	PC-30 & Bentonite	7.44E-10	0.03	0.04
9	Turco 4521A	PC-30 & Silicate	5.69E-8	0.27	0.32
10	Peroxide Bicarbonate	Portland Type 30 Cement	4.09E-8	0.23	0.27
11	Peroxide Bicarbonate	PC-30 & Bentonite	2.52E-10	0.02	0.02
12	Peroxide Bicarbonate	PC-30 & Silicate	5.52E-8	0.27	0.32
13	Potassium Persulfate	Portland Type 30 Cement	1.18E-7	0.39	0.46
14	Potassium Persulfate	PC-30 & Bentonite	8.32E-9	0.10	0.12
15	Potassium Persulfate	PC-30 & Silicate	1.39E-7	0.42	0.50

All waste forms are 5.0 cm right cylinders.

[1] Diffusion coefficients are taken from Table 3 of this report.

[2] It should be noted that the lower the Z value the more concurrent the waste form to semi-infinite media.

processes such as rapid wash-off from the immersed surfaces and chemical interactions between the waste forms and leachant are the principal leaching mechanisms with diffusion playing a minimum role. The total amount of radioactivity released by non-diffusion processes varies with waste composition and type of matrix. During the leaching period between 7 to 120 days, diffusion controlled processes predominated. At long leaching times, ie, several half-lives, radioactive decay becomes significant in the modelling of radionuclide releases from waste forms.

8.0 CONCLUSIONS

1. The following semi-infinite diffusion model with radioactive decay correction is recommended for the prediction of long-term releases from short-term leaching data for all waste forms:

$$\left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right] = \left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right]_o + \sqrt{\frac{D}{\lambda}}\ \mathrm{erf}(\lambda t)$$

2. The leaching behaviour of the waste forms is controlled by non-diffusion processes such as rapid releases, dissolution and chemical interactions between the leachant and the waste solid during the first week of leaching and by diffusion controlled processes at long leaching time. As the leaching periods exceed several half-lives, radioactive decay becomes predominant in the leaching model.

3. Under the same leaching conditions, diffusion coefficients, instantaneous releases and releases at 1 year, 5 years and 20 years from PC-30/bentonite waste forms were substantially lower than those observed for plain PC-30 and PC-30/silicate waste products.

4. In general, diffusion coefficients and instantaneous releases from alkaline permanganate, Turco 4521A and peroxide bicarbonate were lower than those from Turco 4512 and potassium persulfate wastes.

5. PC-30/bentonite waste forms exhibited the highest degree of concurrence to semi-infinite geometry behaviour.

9.0 FUTURE WORK

To test the validity and reliability of Model 2A, it is proposed that cumulative releases from cemented decontamination wastes be measured annually for three years and compared with the predicted releases.

Approved:

O.A. Kupcis
Manager
Chemical Research Department

Submitted:

M.A. Habayeb
Chemist
Organic Section

MAH/lt:aba

BW
RW
RG

REFERENCES

1. H.W. Godbee, E.L. Compere, D.S. Joy, A.H. Kibbey and C.W. Nester, Jr., (Oak Ridge National Laboratory), O.V. Anders (Dow Chemical Company) and R.M. Neilson, Jr., (Brookhaven National Laboratory), "Application of Mass Transport Theory to the Leaching of Radionuclides from Waste Solids," Nucl. and Chem. Waste Mgmt., Vol. 1, 29-35 (1980).

2. J. Moore, H.W. Godbee and A.H. Kibbey, "Leach Behaviour of Hydrofracture Grout Incorporating Radioactive Wastes," Nucl. Technology, Vol. 32, 42-43 (1977).

3. H.W. Godbee and D.S. Joy, "Assessment of the Loss of Radioactive Isotopes from Waste Solids to the Environment. Part I: Background and Theory," ORNL-TM-4333, February, 1974.

4. M.J. Bell, "Analysis of the Diffusion of Radioactivity from Encapsulated Wastes," ORNL-TM-3232, February 1971.

5. Cheng Y. Hung, "Prediction of Long-Term Leachability of a Solidified Radioactive Waste from a Short-Term Leachability Test by a Similitude Law for Leaching System," Nucl. and Chem. Waste Mgmt., Vol. 3, 235-243 (1982).

6. J. Crank, "The Mathematics of Diffusion," Oxford University Press, New York (1956).

7. W. Jost, "Diffusion in Solids, Liquids and Gases," Academic Press, New York (1960).

8. M.A. Habayeb, "Presolidification Treatments of Decontamination Wastes," Ontario Hydro Research Report No 81-468-K (1981).

9. E.D. Hespe, Ed. "Leach Testing of Immobilized Radioactive Waste Solids, A Proposal for a Standard Method," Atomic Energy Review, Vol. 9, 195-205 (1971).

10. Hideo Matsuzura, Noboru Moriyama and Akihiko Ito, "Leaching Behaviour of Tritium from a Hardened Cement Paste," Annals of Nuclear Energy, Vol. 6, 417-423 (1979).

11. M.A. Habayeb, "Leaching of ^{60}Co and ^{134}Cs from Cemented Decontamination Wastes," Ontario Hydro Research Report No. 83-320-K (1983).

12. C. Pescatore and A.J. Machiels, "A Criterion for Selecting Leach Test Specimen Sizes," Nucl. Technology, Vol. 56, 297-300 (1982).

Ontario Hydro

2/2

PREDICTION OF LONG-TERM RELEASES OF ^{134}Cs FROM CEMENTED DECONTAMINATION WASTES BY SEMI-INFINITE DIFFUSION MODELS

Addendum to Report No 84-209-K

M.A. Habayeb
Chemist
Organic Section
Chemical Research Department

RESEARCH DIVISION

91600
new 82-10

COMPLIMENTARY COPY
Please Credit Ontario Hydro Research if
Reproduced in Whole or in Part.

ontario hydro
research division

To

PREDICTION OF LONG-TERM RELEASES OF ^{134}Cs FROM CEMENTED DECONTAMINATION WASTES BY SEMI-INFINITE DIFFUSION MODELS

Addendum to Report No 84-209-K

M.A. Habayeb
Chemist
Organic Section
Chemical Research Department

APPENDICES 1-11
(Pages 23-137)

job	file	date	report no.
740632-537-062	837.83	August 28, 1984	Addendum to 84-209-K

APPENDIX 1

1.1 Derivation of Model 1A/4/

Model 1 provides an estimate of the total amount of radioactivity released without radioactive decay correction. Because radioactive decay may compete with the diffusion mechanism particularly if the radionuclide has a relatively short half-life, it is necessary to correct Model 1 for radioactive decay as follows:

$$F = \left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right) = \sqrt{\frac{D}{\pi}} \int_o^t \frac{e^{-\lambda t}}{\sqrt{t}}\, dt$$

assuming $\lambda t = u^2$

$$\therefore \quad F = \frac{2D}{\pi\lambda} \int_o^{\sqrt{\lambda t}} e^{-u^2}\, du$$

Integrating this equation yields Model 1A as follows:

$$\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right) = \sqrt{\frac{D}{\pi}}\ \mathrm{erf}(\lambda t)$$

erf(λt) values can be found in erf tables.

1.2 Derivation of Model 2A

Model 2A is derived from Model 2 as follows/4/.

$$F = \left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right] = \left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right]_o + 2\sqrt{\frac{D}{\pi}}\, t^{\frac{1}{2}} \text{ [Model 2]} \qquad [I]$$

Adjusting Model 2 for radioactive decay yields,

$$F = \left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right] = \left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right]_o + 2\sqrt{\frac{D}{\pi}} \int_o^t \frac{e^{-\lambda t}}{\sqrt{t}}\, dt \qquad [II]$$

assuming $\lambda t = u^2$

$$\therefore \quad F = \left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right]_o + \frac{2D}{\pi\lambda} \int_o^{\sqrt{\lambda t}} e^{-u^2}\, du \qquad [III]$$

Integrating equation [III] yields,

$$\left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right] = \left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right]_o + \sqrt{\frac{D}{\lambda}}\ \text{erf}(\lambda t) \quad \text{[Model 2A].}$$

SUMMARY OF MODELS

The following Models were used in obtaining the data in Appendices 2 - 11.

Model 1: $$\left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right] = 2\left(\frac{D}{\pi}\right)^{\frac{1}{2}} t^{\frac{1}{2}}$$

Model 1A: $$\left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right] = \sqrt{\frac{D}{\lambda}}\ \mathrm{erf}(\lambda t)$$

Model 2: $$\left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right] = \left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right]_o + 2\left(\frac{D}{\pi}\right)^{\frac{1}{2}} t^{\frac{1}{2}}$$

Model 2A: $$\left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right] = \left[\left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right)\right]_o + \sqrt{\frac{D}{\lambda}}\ \mathrm{erf}(\lambda t)$$

Model 3: is Model 2 applied to the leaching data during the first 4 days leaching (phase 1) and the leaching data from 7 - 120 days (phase 2) separately.

NOTE: Table and Figure Numbers
are followed by the Number
of the Model used in
obtaining the data.

APPENDIX 2

Table 1-1
Predicted and Actual Releases from ALKALINE PERMANGANATE (AP) using Model 1

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 40 ml AP AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.21E-01	4.66E-02	7.46E-02
2	1.41	1.53E-01	6.60E-02	8.74E-02
3	1.73	1.79E-01	8.08E-02	9.80E-02
4	2.00	2.00E-01	9.33E-02	1.07E-01
7	2.65	2.42E-01	1.23E-01	1.18E-01
14	3.74	2.86E-01	1.75E-01	1.12E-01
21	4.58	3.15E-01	2.14E-01	1.01E-01
28	5.29	3.36E-01	2.47E-01	8.97E-02
80	8.94	3.43E-01	4.17E-01	-7.37E-02
120	10.95	3.66E-01	5.11E-01	-1.45E-01
365	19.10	.	8.91E-01	.
730	27.02	.	1.26E+00	.
1095	33.09	.	1.54E+00	.
1460	38.21	.	1.78E+00	.
1825	42.72	.	1.99E+00	.
2190	46.80	.	2.18E+00	.
2555	50.55	.	2.36E+00	.
2920	54.04	.	2.52E+00	.
3285	57.31	.	2.67E+00	.
3650	60.42	.	2.82E+00	.
4015	63.36	.	2.96E+00	.
4380	66.18	.	3.09E+00	.
4745	68.88	.	3.21E+00	.
5110	71.48	.	3.33E+00	.
5475	73.99	.	3.45E+00	.
5840	76.42	.	3.56E+00	.
6205	78.77	.	3.67E+00	.
6570	81.06	.	3.78E+00	.
6935	83.28	.	3.88E+00	.
7300	85.44	.	3.99E+00	.

Data are not corrected for radioactive decay

Table 2-1

Predicted and Actual Releases from ALKALINE PERMANGANATE (AP) using Model 1

Matrix : PC-30 & BENTONITE

Waste form composition: 44 ml AP, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	4.30E-03	2.85E-03	1.45E-03
2	1.41	6.21E-03	4.03E-03	2.19E-03
3	1.73	7.77E-03	4.93E-03	2.84E-03
4	2.00	9.11E-03	5.69E-03	3.42E-03
7	2.65	1.18E-02	7.53E-03	4.27E-03
14	3.74	1.45E-02	1.06E-02	3.90E-03
21	4.58	1.65E-02	1.30E-02	3.42E-03
28	5.29	1.81E-02	1.51E-02	3.06E-03
80	8.94	2.36E-02	2.55E-02	-1.85E-03
120	10.95	2.59E-02	3.12E-02	-5.24E-03
365	19.10	.	5.44E-02	.
730	27.02	.	7.69E-02	.
1095	33.09	.	9.42E-02	.
1460	38.21	.	1.09E-01	.
1825	42.72	.	1.22E-01	.
2190	46.80	.	1.33E-01	.
2555	50.55	.	1.44E-01	.
2920	54.04	.	1.54E-01	.
3285	57.31	.	1.63E-01	.
3650	60.42	.	1.72E-01	.
4015	63.36	.	1.80E-01	.
4380	66.18	.	1.88E-01	.
4745	68.88	.	1.96E-01	.
5110	71.48	.	2.03E-01	.
5475	73.99	.	2.11E-01	.
5840	76.42	.	2.18E-01	.
6205	78.77	.	2.24E-01	.
6570	81.06	.	2.31E-01	.
6935	83.28	.	2.37E-01	.
7300	85.44	.	2.43E-01	.

Data are not corrected for radioactive decay

Table 3-1
Predicted and Actual Releases from ALKALINE PERMANGANATE (AP) using Model 1

Matrix : PC-30 & SILICATE
Waste form composition: 44 ml AP, 100 g PORTLAND TYPE 30 CEMENT, AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.78E-01	6.44E-02	1.13E-01
2	1.41	2.38E-01	9.11E-02	1.47E-01
3	1.73	2.77E-01	1.12E-01	1.65E-01
4	2.00	3.05E-01	1.29E-01	1.77E-01
7	2.65	3.55E-01	1.71E-01	1.85E-01
14	3.74	4.05E-01	2.41E-01	1.64E-01
21	4.58	4.36E-01	2.95E-01	1.41E-01
28	5.29	4.59E-01	3.41E-01	1.18E-01
80	8.94	4.65E-01	5.76E-01	-1.11E-01
120	10.95	4.93E-01	7.06E-01	-2.13E-01
365	19.10	.	1.23E+00	.
730	27.02	.	1.74E+00	.
1095	33.09	.	2.13E+00	.
1460	38.21	.	2.46E+00	.
1825	42.72	.	2.75E+00	.
2190	46.80	.	3.02E+00	.
2555	50.55	.	3.26E+00	.
2920	54.04	.	3.48E+00	.
3285	57.31	.	3.69E+00	.
3650	60.42	.	3.89E+00	.
4015	63.36	.	4.08E+00	.
4380	66.18	.	4.27E+00	.
4745	68.88	.	4.44E+00	.
5110	71.48	.	4.61E+00	.
5475	73.99	.	4.77E+00	.
5840	76.42	.	4.92E+00	.
6205	78.77	.	5.08E+00	.
6570	81.06	.	5.22E+00	.
6935	83.28	.	5.37E+00	.
7300	85.44	.	5.51E+00	.

Data are not corrected for radioactive decay

84-209

Table 4-1

Predicted and Actual Releases from TURCO 4512 using Model 1

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 60 ml TURCO 4512 AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.18E-01	9.00E-02	1.28E-01
2	1.41	2.83E-01	1.27E-01	1.56E-01
3	1.73	3.35E-01	1.56E-01	1.79E-01
4	2.00	3.72E-01	1.80E-01	1.92E-01
7	2.65	4.45E-01	2.38E-01	2.07E-01
14	3.74	5.24E-01	3.37E-01	1.88E-01
21	4.58	5.74E-01	4.12E-01	1.62E-01
28	5.29	6.10E-01	4.76E-01	1.34E-01
80	8.94	7.05E-01	8.05E-01	-9.94E-02
120	10.95	7.25E-01	9.86E-01	-2.60E-01
365	19.10	.	1.72E+00	.
730	27.02	.	2.43E+00	.
1095	33.09	.	2.98E+00	.
1460	38.21	.	3.44E+00	.
1825	42.72	.	3.84E+00	.
2190	46.80	.	4.21E+00	.
2555	50.55	.	4.55E+00	.
2920	54.04	.	4.86E+00	.
3285	57.31	.	5.16E+00	.
3650	60.42	.	5.44E+00	.
4015	63.36	.	5.70E+00	.
4380	66.18	.	5.96E+00	.
4745	68.88	.	6.20E+00	.
5110	71.48	.	6.43E+00	.
5475	73.99	.	6.66E+00	.
5840	76.42	.	6.88E+00	.
6205	78.77	.	7.09E+00	.
6570	81.06	.	7.29E+00	.
6935	83.28	.	7.49E+00	.
7300	85.44	.	7.69E+00	.

Data are not corrected for radioactive decay

Table 5-1

Predicted and Actual Releases from TURCO 4512 using Model 1

Matrix : PC-30 & BENTONITE

Waste form composition: 60 ml TURCO 4512, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	4.52E-02	2.93E-02	1.60E-02
2	1.41	6.62E-02	4.14E-02	2.48E-02
3	1.73	8.36E-02	5.07E-02	3.29E-02
4	2.00	9.85E-02	5.86E-02	3.99E-02
7	2.65	1.25E-01	7.75E-02	4.80E-02
14	3.74	1.54E-01	1.10E-01	4.40E-02
21	4.58	1.75E-01	1.34E-01	4.09E-02
28	5.29	1.92E-01	1.55E-01	3.67E-02
80	8.94	2.40E-01	2.62E-01	-2.24E-02
120	10.95	2.61E-01	3.21E-01	-6.03E-02
365	19.10	.	5.60E-01	.
730	27.02	.	7.92E-01	.
1095	33.09	.	9.69E-01	.
1460	38.21	.	1.12E+00	.
1825	42.72	.	1.25E+00	.
2190	46.80	.	1.37E+00	.
2555	50.55	.	1.48E+00	.
2920	54.04	.	1.58E+00	.
3285	57.31	.	1.68E+00	.
3650	60.42	.	1.77E+00	.
4015	63.36	.	1.86E+00	.
4380	66.18	.	1.94E+00	.
4745	68.88	.	2.02E+00	.
5110	71.48	.	2.09E+00	.
5475	73.99	.	2.17E+00	.
5840	76.42	.	2.24E+00	.
6205	78.77	.	2.31E+00	.
6570	81.06	.	2.37E+00	.
6935	83.28	.	2.44E+00	.
7300	85.44	.	2.50E+00	.

Data are not corrected for radioactive decay

Table 6-1

Predicted and Actual Releases from TURCO 4512 using Model 1

Matrix : PC-30 & SILICATE

Waste form composition: 60 ml TURCO 4512, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.48E-01	8.71E-02	1.61E-01
2	1.41	3.21E-01	1.23E-01	1.98E-01
3	1.73	3.67E-01	1.51E-01	2.16E-01
4	2.00	4.01E-01	1.74E-01	2.27E-01
7	2.65	4.59E-01	2.30E-01	2.28E-01
14	3.74	5.18E-01	3.26E-01	1.93E-01
21	4.58	5.54E-01	3.99E-01	1.55E-01
28	5.29	5.80E-01	4.61E-01	1.19E-01
80	8.94	6.60E-01	7.79E-01	-1.19E-01
120	10.95	6.92E-01	9.54E-01	-2.62E-01
365	19.10	.	1.66E+00	.
730	27.02	.	2.35E+00	.
1095	33.09	.	2.88E+00	.
1460	38.21	.	3.33E+00	.
1825	42.72	.	3.72E+00	.
2190	46.80	.	4.08E+00	.
2555	50.55	.	4.40E+00	.
2920	54.04	.	4.71E+00	.
3285	57.31	.	4.99E+00	.
3650	60.42	.	5.26E+00	.
4015	63.36	.	5.52E+00	.
4380	66.18	.	5.77E+00	.
4745	68.88	.	6.00E+00	.
5110	71.48	.	6.23E+00	.
5475	73.99	.	6.45E+00	.
5840	76.42	.	6.66E+00	.
6205	78.77	.	6.86E+00	.
6570	81.06	.	7.06E+00	.
6935	83.28	.	7.25E+00	.
7300	85.44	.	7.44E+00	.

Data are not corrected for radioactive decay

84-209

Table 7-1
Predicted and Actual Releases from TURCO 4521A using Model 1

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 40 ml TURCO 4521A AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.32E-01	5.10E-02	8.12E-02
2	1.41	1.71E-01	7.21E-02	9.93E-02
3	1.73	1.99E-01	8.83E-02	1.11E-01
4	2.00	2.20E-01	1.02E-01	1.18E-01
7	2.65	2.57E-01	1.35E-01	1.23E-01
14	3.74	2.96E-01	1.91E-01	1.05E-01
21	4.58	3.20E-01	2.34E-01	8.68E-02
28	5.29	3.38E-01	2.70E-01	6.80E-02
80	8.94	3.95E-01	4.56E-01	-6.13E-02
120	10.95	4.14E-01	5.58E-01	-1.44E-01
365	19.10	.	9.74E-01	.
730	27.02	.	1.38E+00	.
1095	33.09	.	1.69E+00	.
1460	38.21	.	1.95E+00	.
1825	42.72	.	2.18E+00	.
2190	46.80	.	2.39E+00	.
2555	50.55	.	2.58E+00	.
2920	54.04	.	2.75E+00	.
3285	57.31	.	2.92E+00	.
3650	60.42	.	3.08E+00	.
4015	63.36	.	3.23E+00	.
4380	66.18	.	3.37E+00	.
4745	68.88	.	3.51E+00	.
5110	71.48	.	3.64E+00	.
5475	73.99	.	3.77E+00	.
5840	76.42	.	3.90E+00	.
6205	78.77	.	4.02E+00	.
6570	81.06	.	4.13E+00	.
6935	83.28	.	4.24E+00	.
7300	85.44	.	4.35E+00	.

Data are not corrected for radioactive decay

Table 8-1

Predicted and Actual Releases from TURCO 4521A using Model 1

Matrix : PC-30 & BENTONITE
Waste form composition: 44 ml TURCO 4521A, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	3.18E-02	8.47E-03	2.33E-02
2	1.41	3.49E-02	1.20E-02	2.29E-02
3	1.73	3.73E-02	1.47E-02	2.27E-02
4	2.00	3.95E-02	1.69E-02	2.26E-02
7	2.65	4.39E-02	2.24E-02	2.15E-02
14	3.74	4.86E-02	3.17E-02	1.69E-02
21	4.58	5.21E-02	3.88E-02	1.33E-02
28	5.29	5.49E-02	4.48E-02	1.01E-02
80	8.94	6.44E-02	7.57E-02	-1.14E-02
120	10.95	6.78E-02	9.27E-02	-2.49E-02
365	19.10	.	1.62E-01	.
730	27.02	.	2.29E-01	.
1095	33.09	.	2.80E-01	.
1460	38.21	.	3.24E-01	.
1825	42.72	.	3.62E-01	.
2190	46.80	.	3.96E-01	.
2555	50.55	.	4.28E-01	.
2920	54.04	.	4.58E-01	.
3285	57.31	.	4.85E-01	.
3650	60.42	.	5.12E-01	.
4015	63.36	.	5.36E-01	.
4380	66.18	.	5.60E-01	.
4745	68.88	.	5.83E-01	.
5110	71.48	.	6.05E-01	.
5475	73.99	.	6.26E-01	.
5840	76.42	.	6.47E-01	.
6205	78.77	.	6.67E-01	.
6570	81.06	.	6.86E-01	.
6935	83.28	.	7.05E-01	.
7300	85.44	.	7.23E-01	.

Data are not corrected for radioactive decay

Table 9-1

Predicted and Actual Releases from TURCO 4521A using Model 1

Matrix : PC-30 & SILICATE
Waste form composition: 44 ml TURCO 4521A, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.30E-01	5.62E-02	7.36E-02
2	1.41	1.75E-01	7.95E-02	9.50E-02
3	1.73	2.06E-01	9.74E-02	1.09E-01
4	2.00	2.28E-01	1.12E-01	1.15E-01
7	2.65	2.73E-01	1.49E-01	1.24E-01
14	3.74	3.19E-01	2.10E-01	1.08E-01
21	4.58	3.48E-01	2.58E-01	9.07E-02
28	5.29	3.71E-01	2.97E-01	7.34E-02
80	8.94	4.43E-01	5.03E-01	-6.03E-02
120	10.95	4.68E-01	6.16E-01	-1.48E-01
365	19.10	.	1.07E+00	.
730	27.02	.	1.52E+00	.
1095	33.09	.	1.86E+00	.
1460	38.21	.	2.15E+00	.
1825	42.72	.	2.40E+00	.
2190	46.80	.	2.63E+00	.
2555	50.55	.	2.84E+00	.
2920	54.04	.	3.04E+00	.
3285	57.31	.	3.22E+00	.
3650	60.42	.	3.40E+00	.
4015	63.36	.	3.56E+00	.
4380	66.18	.	3.72E+00	.
4745	68.88	.	3.87E+00	.
5110	71.48	.	4.02E+00	.
5475	73.99	.	4.16E+00	.
5840	76.42	.	4.30E+00	.
6205	78.77	.	4.43E+00	.
6570	81.06	.	4.56E+00	.
6935	83.28	.	4.68E+00	.
7300	85.44	.	4.80E+00	.

Data are not corrected for radioactive decay

84-209

Table 10-1

Predicted and Actual Releases from PEROXIDE BICARBONATE (PB) using Model 1

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 40 ml PB AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.17E-01	4.90E-02	6.75E-02
2	1.41	1.52E-01	6.94E-02	8.31E-02
3	1.73	1.79E-01	8.49E-02	9.41E-02
4	2.00	2.00E-01	9.81E-02	1.02E-01
7	2.65	2.42E-01	1.30E-01	1.12E-01
14	3.74	2.83E-01	1.83E-01	1.00E-01
21	4.58	3.09E-01	2.25E-01	8.39E-02
28	5.29	3.26E-01	2.59E-01	6.69E-02
80	8.94	3.83E-01	4.39E-01	-5.54E-02
120	10.95	4.03E-01	5.37E-01	-1.34E-01
365	19.10	.	9.37E-01	.
730	27.02	.	1.33E+00	.
1095	33.09	.	1.62E+00	.
1460	38.21	.	1.87E+00	.
1825	42.72	.	2.10E+00	.
2190	46.80	.	2.29E+00	.
2555	50.55	.	2.48E+00	.
2920	54.04	.	2.65E+00	.
3285	57.31	.	2.81E+00	.
3650	60.42	.	2.96E+00	.
4015	63.36	.	3.11E+00	.
4380	66.18	.	3.25E+00	.
4745	68.88	.	3.38E+00	.
5110	71.48	.	3.51E+00	.
5475	73.99	.	3.63E+00	.
5840	76.42	.	3.75E+00	.
6205	78.77	.	3.86E+00	.
6570	81.06	.	3.98E+00	.
6935	83.28	.	4.08E+00	.
7300	85.44	.	4.19E+00	.

Data are not corrected for radioactive decay

84-209

Table 11-1

Predicted and Actual Releases from PEROXIDE BICARBONATE (PB) using Model 1

Matrix : PC-30 & BENTONITE
Waste form composition: 44 ml PB, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	4.06E-03	2.81E-03	1.25E-03
2	1.41	5.99E-03	3.98E-03	2.01E-03
3	1.73	7.62E-03	4.88E-03	2.74E-03
4	2.00	8.99E-03	5.63E-03	3.36E-03
7	2.65	1.18E-02	7.45E-03	4.33E-03
14	3.74	1.46E-02	1.05E-02	4.04E-03
21	4.58	1.65E-02	1.29E-02	3.61E-03
28	5.29	1.81E-02	1.49E-02	3.23E-03
60	8.94	2.33E-02	2.52E-02	-1.87E-03
120	10.95	2.54E-02	3.08E-02	-5.39E-03
365	19.10	.	5.38E-02	.
730	27.02	.	7.61E-02	.
1095	33.09	.	9.31E-02	.
1460	38.21	.	1.08E-01	.
1825	42.72	.	1.20E-01	.
2190	46.80	.	1.32E-01	.
2555	50.55	.	1.42E-01	.
2920	54.04	.	1.52E-01	.
3285	57.31	.	1.61E-01	.
3650	60.42	.	1.70E-01	.
4015	63.36	.	1.78E-01	.
4380	66.18	.	1.86E-01	.
4745	68.88	.	1.94E-01	.
5110	71.48	.	2.01E-01	.
5475	73.99	.	2.08E-01	.
5840	76.42	.	2.15E-01	.
6205	78.77	.	2.22E-01	.
6570	81.06	.	2.28E-01	.
6935	83.28	.	2.34E-01	.
7300	85.44	.	2.41E-01	.

Data are not corrected for radioactive decay

84-209

Table 12-1

Predicted and Actual Releases from PEROXIDE BICARBONATE (PB) using Model 1

Matrix : PC-30 & SILICATE

Waste form composition: 44 ml PB, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.38E-01	5.81E-02	8.04E-02
2	1.41	1.86E-01	8.22E-02	1.03E-01
3	1.73	2.18E-01	1.01E-01	1.17E-01
4	2.00	2.43E-01	1.16E-01	1.27E-01
7	2.65	2.90E-01	1.54E-01	1.36E-01
14	3.74	3.35E-01	2.17E-01	1.18E-01
21	4.58	3.64E-01	2.66E-01	9.79E-02
28	5.29	3.86E-01	3.07E-01	7.85E-02
80	8.94	4.52E-01	5.20E-01	-6.75E-02
120	10.95	4.77E-01	6.36E-01	-1.59E-01
365	19.10	.	1.11E+00	.
730	27.02	.	1.57E+00	.
1095	33.09	.	1.92E+00	.
1460	38.21	.	2.22E+00	.
1825	42.72	.	2.48E+00	.
2190	46.80	.	2.72E+00	.
2555	50.55	.	2.94E+00	.
2920	54.04	.	3.14E+00	.
3285	57.31	.	3.33E+00	.
3650	60.42	.	3.51E+00	.
4015	63.36	.	3.68E+00	.
4380	66.18	.	3.85E+00	.
4745	68.88	.	4.00E+00	.
5110	71.48	.	4.15E+00	.
5475	73.99	.	4.30E+00	.
5840	76.42	.	4.44E+00	.
6205	78.77	.	4.58E+00	.
6570	81.06	.	4.71E+00	.
6935	83.28	.	4.84E+00	.
7300	85.44	.	4.96E+00	.

Data are not corrected for radioactive decay

84-209

13-1

Table

Predicted and Actual Releases from POTASSIUM PERSULFATE (PP) using Model 1

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 70 ml PP AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.06E-01	8.71E-02	1.18E-01
2	1.41	2.78E-01	1.23E-01	1.55E-01
3	1.73	3.29E-01	1.51E-01	1.78E-01
4	2.00	3.69E-01	1.74E-01	1.94E-01
7	2.65	4.38E-01	2.30E-01	2.08E-01
14	3.74	5.10E-01	3.26E-01	1.84E-01
21	4.58	5.55E-01	3.99E-01	1.56E-01
28	5.29	5.87E-01	4.61E-01	1.26E-01
80	8.94	6.76E-01	7.79E-01	-1.03E-01
120	10.95	7.05E-01	9.54E-01	-2.49E-01
365	19.10	.	1.66E+00	.
730	27.02	.	2.35E+00	.
1095	33.09	.	2.88E+00	.
1460	38.21	.	3.33E+00	.
1825	42.72	.	3.72E+00	.
2190	46.80	.	4.08E+00	.
2555	50.55	.	4.40E+00	.
2920	54.04	.	4.71E+00	.
3285	57.31	.	4.99E+00	.
3650	60.42	.	5.26E+00	.
4015	63.36	.	5.52E+00	.
4380	66.18	.	5.76E+00	.
4745	68.88	.	6.00E+00	.
5110	71.48	.	6.23E+00	.
5475	73.99	.	6.44E+00	.
5840	76.42	.	6.66E+00	.
6205	78.77	.	6.86E+00	.
6570	81.06	.	7.06E+00	.
6935	83.28	.	7.25E+00	.
7300	85.44	.	7.44E+00	.

Data are not corrected for radioactive decay

Table 14-1
Predicted and Actual Releases from POTASSIUM PERSULFATE (PP) using Model-1

Matrix : PC-30 & BENTONITE
Waste form composition: 70 ml PP, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	3.88E-02	1.90E-02	1.98E-02
2	1.41	4.86E-02	2.69E-02	2.16E-02
3	1.73	6.01E-02	3.30E-02	2.71E-02
4	2.00	6.98E-02	3.81E-02	3.17E-02
7	2.65	8.74E-02	5.03E-02	3.70E-02
14	3.74	1.05E-01	7.12E-02	3.38E-02
21	4.58	1.17E-01	8.72E-02	2.99E-02
28	5.29	1.27E-01	1.01E-01	2.60E-02
80	8.94	1.52E-01	1.70E-01	-1.79E-02
120	10.95	1.63E-01	2.08E-01	-4.56E-02
365	19.10	.	3.64E-01	.
730	27.02	.	5.14E-01	.
1095	33.09	.	6.30E-01	.
1460	38.21	.	7.27E-01	.
1825	42.72	.	8.13E-01	.
2190	46.80	.	8.90E-01	.
2555	50.55	.	9.62E-01	.
2920	54.04	.	1.03E+00	.
3285	57.31	.	1.09E+00	.
3650	60.42	.	1.15E+00	.
4015	63.36	.	1.21E+00	.
4380	66.18	.	1.26E+00	.
4745	68.88	.	1.31E+00	.
5110	71.48	.	1.36E+00	.
5475	73.99	.	1.41E+00	.
5840	76.42	.	1.45E+00	.
6205	78.77	.	1.50E+00	.
6570	81.06	.	1.54E+00	.
6935	83.28	.	1.58E+00	.
7300	85.44	.	1.63E+00	.

Data are not corrected for radioactive decay

Table 15-1

Predicted and Actual Releases from POTASSIUM PERSULFATE (PP) using Model 1

Matrix : PC-30 & SILICATE
Waste form composition: 70 ml PP, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.08E-01	8.86E-02	1.19E-01
2	1.41	2.79E-01	1.25E-01	1.54E-01
3	1.73	3.28E-01	1.54E-01	1.75E-01
4	2.00	3.66E-01	1.77E-01	1.89E-01
7	2.65	4.29E-01	2.35E-01	1.95E-01
14	3.74	5.04E-01	3.32E-01	1.72E-01
21	4.58	5.51E-01	4.06E-01	1.44E-01
28	5.29	5.84E-01	4.69E-01	1.15E-01
80	8.94	6.89E-01	7.93E-01	-1.03E-01
120	10.95	7.41E-01	9.71E-01	-2.30E-01
365	19.10	.	1.69E+00	.
730	27.02	.	2.39E+00	.
1095	33.09	.	2.93E+00	.
1460	38.21	.	3.39E+00	.
1825	42.72	.	3.79E+00	.
2190	46.80	.	4.15E+00	.
2555	50.55	.	4.48E+00	.
2920	54.04	.	4.79E+00	.
3285	57.31	.	5.08E+00	.
3650	60.42	.	5.36E+00	.
4015	63.36	.	5.62E+00	.
4380	66.18	.	5.87E+00	.
4745	68.88	.	6.11E+00	.
5110	71.48	.	6.34E+00	.
5475	73.99	.	6.56E+00	.
5840	76.42	.	6.77E+00	.
6205	78.77	.	6.98E+00	.
6570	81.06	.	7.18E+00	.
6935	83.28	.	7.38E+00	.
7300	85.44	.	7.57E+00	.

Data are not corrected for radioactive decay

APPENDIX 3

Table 1-1A

Predicted and Actual Releases from ALKALINE PERMANGANATE (AP) using Model 1A
Corrected for radioactive decay

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 40 ml AP AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.21E-01	4.27E-03	1.17E-01
2	1.41	1.53E-01	8.54E-03	1.45E-01
3	1.73	1.79E-01	1.28E-02	1.66E-01
4	2.00	2.00E-01	1.71E-02	1.83E-01
7	2.65	2.42E-01	2.99E-02	2.12E-01
14	3.74	2.86E-01	5.98E-02	2.26E-01
21	4.58	3.15E-01	8.97E-02	2.25E-01
28	5.29	3.36E-01	1.20E-01	2.17E-01
80	8.94	3.43E-01	3.41E-01	2.41E-03
120	10.95	3.66E-01	5.10E-01	-1.45E-01
365	19.10	.	1.50E+00	.
730	27.02	.	2.70E+00	.
1095	33.09	.	3.46E+00	.
1460	38.21	.	3.85E+00	.
1825	42.72	.	4.00E+00	.
2190	46.80	.	4.05E+00	.
2555	50.55	.	4.07E+00	.
2920	54.04	.	4.07E+00	.
3285	57.31	.	4.07E+00	.
3650	60.42	.	4.07E+00	.
4015	63.36	.	4.07E+00	.
4380	66.18	.	4.07E+00	.
4745	68.88	.	4.07E+00	.
5110	71.48	.	4.07E+00	.
5475	73.99	.	4.07E+00	.
5840	76.42	.	4.07E+00	.
6205	78.77	.	4.07E+00	.
6570	81.06	.	4.07E+00	.
6935	83.28	.	4.07E+00	.
7300	85.44	.	4.07E+00	.

Table 2-1A

Predicted and Actual Releases from ALKALINE PERMANGANATE (AP) using Model 1A
Corrected for radioactive decay

Matrix : PC-30 & BENTONITE
Waste form composition: 44 ml AP, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	4.30E-03	2.80E-04	4.02E-03
2	1.41	6.21E-03	5.60E-04	5.65E-03
3	1.73	7.77E-03	8.39E-04	6.93E-03
4	2.00	9.11E-03	1.12E-03	7.99E-03
7	2.65	1.18E-02	1.96E-03	9.84E-03
14	3.74	1.45E-02	3.92E-03	1.06E-02
21	4.58	1.65E-02	5.88E-03	1.06E-02
28	5.29	1.81E-02	7.83E-03	1.03E-02
80	8.94	2.36E-02	2.23E-02	1.26E-03
120	10.95	2.59E-02	3.34E-02	-7.50E-03
365	19.10	.	9.83E-02	.
730	27.02	.	1.77E-01	.
1095	33.09	.	2.27E-01	.
1460	38.21	.	2.52E-01	.
1825	42.72	.	2.62E-01	.
2190	46.80	.	2.66E-01	.
2555	50.55	.	2.66E-01	.
2920	54.04	.	2.67E-01	.
3285	57.31	.	2.67E-01	.
3650	60.42	.	2.67E-01	.
4015	63.36	.	2.67E-01	.
4380	66.18	.	2.67E-01	.
4745	68.88	.	2.67E-01	.
5110	71.48	.	2.67E-01	.
5475	73.99	.	2.67E-01	.
5840	76.42	.	2.67E-01	.
6205	78.77	.	2.67E-01	.
6570	81.06	.	2.67E-01	.
6935	83.28	.	2.67E-01	.
7300	85.44	.	2.67E-01	.

Table 3-1A

Predicted and Actual Releases from ALKALINE PERMANGANATE (AP) using Model 1A
Corrected for radioactive decay

Matrix : PC-30 & SILICATE
Waste form composition: 44 ml AP, 100 g PORTLAND TYPE 30 CEMENT, AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.78E-01	5.82E-03	1.72E-01
2	1.41	2.38E-01	1.16E-02	2.26E-01
3	1.73	2.77E-01	1.75E-02	2.59E-01
4	2.00	3.05E-01	2.33E-02	2.82E-01
7	2.65	3.55E-01	4.07E-02	3.14E-01
14	3.74	4.05E-01	8.14E-02	3.23E-01
21	4.58	4.36E-01	1.22E-01	3.14E-01
28	5.29	4.59E-01	1.63E-01	2.96E-01
60	8.94	4.65E-01	4.65E-01	8.44E-04
120	10.95	4.93E-01	6.95E-01	-2.02E-01
365	19.10	.	2.04E+00	.
730	27.02	.	3.68E+00	.
1095	33.09	.	4.71E+00	.
1460	38.21	.	5.24E+00	.
1825	42.72	.	5.45E+00	.
2190	46.80	.	5.52E+00	.
2555	50.55	.	5.54E+00	.
2920	54.04	.	5.54E+00	.
3285	57.31	.	5.54E+00	.
3650	60.42	.	5.54E+00	.
4015	63.36	.	5.54E+00	.
4380	66.18	.	5.54E+00	.
4745	68.88	.	5.54E+00	.
5110	71.48	.	5.54E+00	.
5475	73.99	.	5.54E+00	.
5840	76.42	.	5.54E+00	.
6205	78.77	.	5.54E+00	.
6570	81.06	.	5.54E+00	.
6935	83.28	.	5.54E+00	.
7300	85.44	.	5.54E+00	.

Table 4-1A

Predicted and Actual Releases from TURCO 4512 using Model 1A
Corrected for radioactive decay

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 60 ml TURCO 4512 AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.18E-01	8.39E-03	2.09E-01
2	1.41	2.83E-01	1.68E-02	2.67E-01
3	1.73	3.35E-01	2.52E-02	3.09E-01
4	2.00	3.72E-01	3.36E-02	3.38E-01
7	2.65	4.45E-01	5.87E-02	3.86E-01
14	3.74	5.24E-01	1.17E-01	4.07E-01
21	4.58	5.74E-01	1.76E-01	3.98E-01
28	5.29	6.10E-01	2.35E-01	3.75E-01
80	8.94	7.05E-01	6.70E-01	3.56E-02
120	10.95	7.25E-01	1.00E+00	-2.77E-01
365	19.10	.	2.95E+00	.
730	27.02	.	5.30E+00	.
1095	33.09	.	6.80E+00	.
1460	38.21	.	7.55E+00	.
1825	42.72	.	7.86E+00	.
2190	46.80	.	7.96E+00	.
2555	50.55	.	7.99E+00	.
2920	54.04	.	7.99E+00	.
3285	57.31	.	7.99E+00	.
3650	60.42	.	7.99E+00	.
4015	63.36	.	7.99E+00	.
4380	66.18	.	7.99E+00	.
4745	68.88	.	7.99E+00	.
5110	71.48	.	7.99E+00	.
5475	73.99	.	7.99E+00	.
5840	76.42	.	7.99E+00	.
6205	78.77	.	7.99E+00	.
6570	81.06	.	7.99E+00	.
6935	83.28	.	7.99E+00	.
7300	85.44	.	7.99E+00	.

Table 5-1A

Predicted and Actual Releases from TURCO 4512 using Model 1A
Corrected for radioactive decay

Matrix : PC-30 & BENTONITE
Waste form composition: 60 ml TURCO 4512, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	4.52E-02	2.85E-03	4.24E-02
2	1.41	6.62E-02	5.70E-03	6.05E-02
3	1.73	8.36E-02	8.55E-03	7.50E-02
4	2.00	9.85E-02	1.14E-02	8.71E-02
7	2.65	1.25E-01	2.00E-02	1.06E-01
14	3.74	1.54E-01	3.99E-02	1.14E-01
21	4.58	1.75E-01	5.99E-02	1.15E-01
28	5.29	1.92E-01	7.98E-02	1.12E-01
80	8.94	2.40E-01	2.28E-01	1.20E-02
120	10.95	2.61E-01	3.41E-01	-8.01E-02
365	19.10	.	1.00E+00	.
730	27.02	.	1.80E+00	.
1095	33.09	.	2.31E+00	.
1460	38.21	.	2.57E+00	.
1825	42.72	.	2.67E+00	.
2190	46.80	.	2.71E+00	.
2555	50.55	.	2.71E+00	.
2920	54.04	.	2.72E+00	.
3285	57.31	.	2.72E+00	.
3650	60.42	.	2.72E+00	.
4015	63.36	.	2.72E+00	.
4380	66.18	.	2.72E+00	.
4745	68.88	.	2.72E+00	.
5110	71.48	.	2.72E+00	.
5475	73.99	.	2.72E+00	.
5840	76.42	.	2.72E+00	.
6205	78.77	.	2.72E+00	.
6570	81.06	.	2.72E+00	.
6935	83.28	.	2.72E+00	.
7300	85.44	.	2.72E+00	.

Table 6-1A

Predicted and Actual Releases from TURCO 4512 using Model 1A
Corrected for radioactive decay

Matrix : PC-30 & SILICATE
Waste form composition: 60 ml TURCO 4512, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.48E-01	8.01E-03	2.40E-01
2	1.41	3.21E-01	1.60E-02	3.05E-01
3	1.73	3.67E-01	2.40E-02	3.43E-01
4	2.00	4.01E-01	3.20E-02	3.69E-01
7	2.65	4.59E-01	5.60E-02	4.03E-01
14	3.74	5.18E-01	1.12E-01	4.06E-01
21	4.58	5.54E-01	1.68E-01	3.86E-01
28	5.29	5.80E-01	2.24E-01	3.56E-01
80	8.94	6.60E-01	6.39E-01	2.08E-02
120	10.95	6.92E-01	9.57E-01	-2.64E-01
365	19.10	.	2.81E+00	.
730	27.02	.	5.06E+00	.
1095	33.09	.	6.49E+00	.
1460	38.21	.	7.21E+00	.
1825	42.72	.	7.50E+00	.
2190	46.80	.	7.60E+00	.
2555	50.55	.	7.62E+00	.
2920	54.04	.	7.63E+00	.
3285	57.31	.	7.63E+00	.
3650	60.42	.	7.63E+00	.
4015	63.36	.	7.63E+00	.
4380	66.18	.	7.63E+00	.
4745	68.88	.	7.63E+00	.
5110	71.48	.	7.63E+00	.
5475	73.99	.	7.63E+00	.
5840	76.42	.	7.63E+00	.
6205	78.77	.	7.63E+00	.
6570	81.06	.	7.63E+00	.
6935	83.28	.	7.63E+00	.
7300	85.44	.	7.63E+00	.

Table 7-1A

Predicted and Actual Releases from TURCO 4521A using Model 1A
Corrected for radioactive decay

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 40 ml TURCO 4521A AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.32E-01	4.74E-03	1.27E-01
2	1.41	1.71E-01	9.49E-03	1.62E-01
3	1.73	1.99E-01	1.42E-02	1.85E-01
4	2.00	2.20E-01	1.90E-02	2.01E-01
7	2.65	2.57E-01	3.32E-02	2.24E-01
14	3.74	2.96E-01	6.64E-02	2.30E-01
21	4.58	3.20E-01	9.96E-02	2.21E-01
28	5.29	3.38E-01	1.33E-01	2.05E-01
80	8.94	3.95E-01	3.79E-01	1.59E-02
120	10.95	4.14E-01	5.67E-01	-1.53E-01
365	19.10	.	1.67E+00	.
730	27.02	.	3.00E+00	.
1095	33.09	.	3.84E+00	.
1460	38.21	.	4.27E+00	.
1825	42.72	.	4.45E+00	.
2190	46.80	.	4.50E+00	.
2555	50.55	.	4.52E+00	.
2920	54.04	.	4.52E+00	.
3285	57.31	.	4.52E+00	.
3650	60.42	.	4.52E+00	.
4015	63.36	.	4.52E+00	.
4380	66.18	.	4.52E+00	.
4745	68.88	.	4.52E+00	.
5110	71.48	.	4.52E+00	.
5475	73.99	.	4.52E+00	.
5840	76.42	.	4.52E+00	.
6205	78.77	.	4.52E+00	.
6570	81.06	.	4.52E+00	.
6935	83.28	.	4.52E+00	.
7300	85.44	.	4.52E+00	.

Table 8-1A

Predicted and Actual Releases from TURCO 4521A using Model 1A
Corrected for radioactive decay

Matrix : PC-30 & BENTONITE
Waste form composition: 44 ml TURCO 4521A, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	3.18E-02	7.78E-04	3.10E-02
2	1.41	3.49E-02	1.56E-03	3.33E-02
3	1.73	3.73E-02	2.33E-03	3.50E-02
4	2.00	3.95E-02	3.11E-03	3.64E-02
7	2.65	4.39E-02	5.45E-03	3.85E-02
14	3.74	4.86E-02	1.09E-02	3.77E-02
21	4.58	5.21E-02	1.63E-02	3.57E-02
28	5.29	5.49E-02	2.18E-02	3.31E-02
80	8.94	6.44E-02	6.21E-02	2.24E-03
120	10.95	6.78E-02	9.30E-02	-2.51E-02
365	19.10	.	2.73E-01	.
730	27.02	.	4.91E-01	.
1095	33.09	.	6.30E-01	.
1460	38.21	.	7.00E-01	.
1825	42.72	.	7.29E-01	.
2190	46.80	.	7.38E-01	.
2555	50.55	.	7.40E-01	.
2920	54.04	.	7.41E-01	.
3285	57.31	.	7.41E-01	.
3650	60.42	.	7.41E-01	.
4015	63.36	.	7.41E-01	.
4380	66.18	.	7.41E-01	.
4745	68.88	.	7.41E-01	.
5110	71.48	.	7.41E-01	.
5475	73.99	.	7.41E-01	.
5840	76.42	.	7.41E-01	.
6205	78.77	.	7.41E-01	.
6570	81.06	.	7.41E-01	.
6935	83.28	.	7.41E-01	.
7300	85.44	.	7.41E-01	.

Table 9-1A

Predicted and Actual Releases from TURCO 4521A using Model 1A
Corrected for radioactive decay

Matrix : PC-30 & SILICATE
Waste form composition: 44 ml TURCO 4521A, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.30E-01	5.29E-03	1.25E-01
2	1.41	1.75E-01	1.06E-02	1.64E-01
3	1.73	2.06E-01	1.59E-02	1.90E-01
4	2.00	2.28E-01	2.12E-02	2.06E-01
7	2.65	2.73E-01	3.71E-02	2.36E-01
14	3.74	3.19E-01	7.41E-02	2.44E-01
21	4.58	3.48E-01	1.11E-01	2.37E-01
28	5.29	3.71E-01	1.48E-01	2.23E-01
80	8.94	4.43E-01	4.23E-01	1.98E-02
120	10.95	4.68E-01	6.33E-01	-1.65E-01
365	19.10	.	1.86E+00	.
730	27.02	.	3.34E+00	.
1095	33.09	.	4.29E+00	.
1460	38.21	.	4.77E+00	.
1825	42.72	.	4.96E+00	.
2190	46.80	.	5.02E+00	.
2555	50.55	.	5.04E+00	.
2920	54.04	.	5.04E+00	.
3285	57.31	.	5.04E+00	.
3650	60.42	.	5.04E+00	.
4015	63.36	.	5.04E+00	.
4380	66.18	.	5.04E+00	.
4745	68.88	.	5.04E+00	.
5110	71.48	.	5.04E+00	.
5475	73.99	.	5.04E+00	.
5840	76.42	.	5.04E+00	.
6205	78.77	.	5.04E+00	.
6570	81.06	.	5.04E+00	.
6935	83.28	.	5.04E+00	.
7300	85.44	.	5.04E+00	.

Table 10-1A
Predicted and Actual Releases from PEROXIDE BICARBONATE (PB) using Model 1A
Corrected for radioactive decay

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 40 ml PB AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.17E-01	4.60E-03	1.12E-01
2	1.41	1.52E-01	9.19E-03	1.43E-01
3	1.73	1.79E-01	1.38E-02	1.65E-01
4	2.00	2.00E-01	1.84E-02	1.82E-01
7	2.65	2.42E-01	3.22E-02	2.09E-01
14	3.74	2.83E-01	6.44E-02	2.19E-01
21	4.58	3.09E-01	9.65E-02	2.12E-01
28	5.29	3.26E-01	1.29E-01	1.98E-01
80	8.94	3.83E-01	3.67E-01	1.62E-02
120	10.95	4.03E-01	5.49E-01	-1.46E-01
365	19.10	.	1.62E+00	.
730	27.02	.	2.90E+00	.
1095	33.09	.	3.72E+00	.
1460	38.21	.	4.14E+00	.
1825	42.72	.	4.31E+00	.
2190	46.80	.	4.36E+00	.
2555	50.55	.	4.38E+00	.
2920	54.04	.	4.38E+00	.
3285	57.31	.	4.38E+00	.
3650	60.42	.	4.38E+00	.
4015	63.36	.	4.38E+00	.
4380	66.18	.	4.38E+00	.
4745	68.88	.	4.38E+00	.
5110	71.48	.	4.38E+00	.
5475	73.99	.	4.38E+00	.
5840	76.42	.	4.38E+00	.
6205	78.77	.	4.38E+00	.
6570	81.06	.	4.38E+00	.
6935	83.28	.	4.38E+00	.
7300	85.44	.	4.38E+00	.

Table 11-1A

Predicted and Actual Releases from PEROXIDE BICARBONATE (PB) using Model 1A
Corrected for radioactive decay

Matrix : PC-30 & BENTONITE
Waste form composition: 44 ml PB, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	4.06E-03	2.76E-04	3.79E-03
2	1.41	5.99E-03	5.52E-04	5.44E-03
3	1.73	7.62E-03	8.28E-04	6.79E-03
4	2.00	8.99E-03	1.10E-03	7.89E-03
7	2.65	1.18E-02	1.93E-03	9.85E-03
14	3.74	1.46E-02	3.87E-03	1.07E-02
21	4.58	1.65E-02	5.80E-03	1.07E-02
28	5.29	1.81E-02	7.73E-03	1.04E-02
80	8.94	2.33E-02	2.20E-02	1.26E-03
120	10.95	2.54E-02	3.30E-02	-7.55E-03
365	19.10	.	9.70E-02	.
730	27.02	.	1.74E-01	.
1095	33.09	.	2.24E-01	.
1460	38.21	.	2.49E-01	.
1825	42.72	.	2.59E-01	.
2190	46.80	.	2.62E-01	.
2555	50.55	.	2.63E-01	.
2920	54.04	.	2.63E-01	.
3285	57.31	.	2.63E-01	.
3650	60.42	.	2.63E-01	.
4015	63.36	.	2.63E-01	.
4380	66.18	.	2.63E-01	.
4745	68.88	.	2.63E-01	.
5110	71.48	.	2.63E-01	.
5475	73.99	.	2.63E-01	.
5840	76.42	.	2.63E-01	.
6205	78.77	.	2.63E-01	.
6570	81.06	.	2.63E-01	.
6935	83.28	.	2.63E-01	.
7300	85.44	.	2.63E-01	.

Table 12-1A

Predicted and Actual Releases from PEROXIDE BICARBONATE (PB) using Model 1A
Corrected for radioactive decay

Matrix : PC-30 & SILICATE
Waste form composition: 44 ml PB, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.38E-01	5.44E-03	1.33E-01
2	1.41	1.66E-01	1.09E-02	1.75E-01
3	1.73	2.18E-01	1.63E-02	2.02E-01
4	2.00	2.43E-01	2.17E-02	2.21E-01
7	2.65	2.90E-01	3.80E-02	2.52E-01
14	3.74	3.35E-01	7.61E-02	2.59E-01
21	4.58	3.64E-01	1.14E-01	2.50E-01
28	5.29	3.86E-01	1.52E-01	2.34E-01
80	8.94	4.52E-01	4.34E-01	1.81E-02
120	10.95	4.77E-01	6.50E-01	-1.72E-01
365	19.10	.	1.91E+00	.
730	27.02	.	3.43E+00	.
1095	33.09	.	4.40E+00	.
1460	38.21	.	4.89E+00	.
1825	42.72	.	5.09E+00	.
2190	46.80	.	5.16E+00	.
2555	50.55	.	5.17E+00	.
2920	54.04	.	5.18E+00	.
3285	57.31	.	5.18E+00	.
3650	60.42	.	5.18E+00	.
4015	63.36	.	5.18E+00	.
4380	66.18	.	5.18E+00	.
4745	68.88	.	5.18E+00	.
5110	71.48	.	5.18E+00	.
5475	73.99	.	5.18E+00	.
5840	76.42	.	5.18E+00	.
6205	78.77	.	5.18E+00	.
6570	81.06	.	5.18E+00	.
6935	83.28	.	5.18E+00	.
7300	85.44	.	5.18E+00	.

84-209

Table 13-1A

Predicted and Actual Releases from POTASSIUM PERSULFATE (PP) using Model 1A
Corrected for radioactive decay

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 70 ml PP AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.06E-01	8.11E-03	1.97E-01
2	1.41	2.78E-01	1.62E-02	2.62E-01
3	1.73	3.29E-01	2.43E-02	3.04E-01
4	2.00	3.69E-01	3.24E-02	3.36E-01
7	2.65	4.38E-01	5.68E-02	3.81E-01
14	3.74	5.10E-01	1.14E-01	3.95E-01
21	4.58	5.55E-01	1.70E-01	3.84E-01
28	5.29	5.87E-01	2.27E-01	3.60E-01
80	8.94	6.76E-01	6.48E-01	2.79E-02
120	10.95	7.05E-01	9.69E-01	-2.64E-01
365	19.10	.	2.85E+00	.
730	27.02	.	5.12E+00	.
1095	33.09	.	6.57E+00	.
1460	38.21	.	7.30E+00	.
1825	42.72	.	7.60E+00	.
2190	46.80	.	7.70E+00	.
2555	50.55	.	7.72E+00	.
2920	54.04	.	7.73E+00	.
3285	57.31	.	7.73E+00	.
3650	60.42	.	7.73E+00	.
4015	63.36	.	7.73E+00	.
4380	66.18	.	7.73E+00	.
4745	68.88	.	7.73E+00	.
5110	71.48	.	7.73E+00	.
5475	73.99	.	7.73E+00	.
5840	76.42	.	7.73E+00	.
6205	78.77	.	7.73E+00	.
6570	81.06	.	7.73E+00	.
6935	83.28	.	7.73E+00	.
7300	85.44	.	7.73E+00	.

Table 14-1A

Predicted and Actual Releases from POTASSIUM PERSULFATE (PP) using Model 1A
Corrected for radioactive decay

Matrix : PC-30 & BENTONITE
Waste form composition: 70 ml PP, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	3.88E-02	1.82E-03	3.70E-02
2	1.41	4.86E-02	3.64E-03	4.49E-02
3	1.73	6.01E-02	5.46E-03	5.46E-02
4	2.00	6.98E-02	7.28E-03	6.25E-02
7	2.65	8.74E-02	1.27E-02	7.47E-02
14	3.74	1.05E-01	2.55E-02	7.95E-02
21	4.58	1.17E-01	3.82E-02	7.89E-02
28	5.29	1.27E-01	5.09E-02	7.57E-02
80	8.94	1.52E-01	1.45E-01	7.03E-03
120	10.95	1.63E-01	2.17E-01	-5.45E-02
365	19.10	.	6.39E-01	.
730	27.02	.	1.15E+00	.
1095	33.09	.	1.47E+00	.
1460	38.21	.	1.64E+00	.
1825	42.72	.	1.70E+00	.
2190	46.80	.	1.73E+00	.
2555	50.55	.	1.73E+00	.
2920	54.04	.	1.73E+00	.
3285	57.31	.	1.73E+00	.
3650	60.42	.	1.73E+00	.
4015	63.36	.	1.73E+00	.
4380	66.18	.	1.73E+00	.
4745	68.88	.	1.73E+00	.
5110	71.48	.	1.73E+00	.
5475	73.99	.	1.73E+00	.
5840	76.42	.	1.73E+00	.
6205	78.77	.	1.73E+00	.
6570	81.06	.	1.73E+00	.
6935	83.28	.	1.73E+00	.
7300	85.44	.	1.73E+00	.

84-209

Table 15-1A

Predicted and Actual Releases from POTASSIUM PERSULFATE (PP) using Model 1A
Corrected for radioactive decay

Matrix : PC-30 & SILICATE
Waste form composition: 70 ml PP, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.08E-01	8.34E-03	1.99E-01
2	1.41	2.79E-01	1.67E-02	2.62E-01
3	1.73	3.28E-01	2.50E-02	3.03E-01
4	2.00	3.66E-01	3.34E-02	3.33E-01
7	2.65	4.29E-01	5.84E-02	3.71E-01
14	3.74	5.04E-01	1.17E-01	3.87E-01
21	4.58	5.51E-01	1.75E-01	3.75E-01
28	5.29	5.84E-01	2.33E-01	3.50E-01
80	8.94	6.89E-01	6.66E-01	2.34E-02
120	10.95	7.41E-01	9.97E-01	-2.56E-01
365	19.10	.	2.93E+00	.
730	27.02	.	5.27E+00	.
1095	33.09	.	6.76E+00	.
1460	38.21	.	7.51E+00	.
1825	42.72	.	7.81E+00	.
2190	46.80	.	7.91E+00	.
2555	50.55	.	7.94E+00	.
2920	54.04	.	7.94E+00	.
3285	57.31	.	7.94E+00	.
3650	60.42	.	7.94E+00	.
4015	63.36	.	7.94E+00	.
4380	66.18	.	7.94E+00	.
4745	68.88	.	7.94E+00	.
5110	71.48	.	7.94E+00	.
5475	73.99	.	7.94E+00	.
5840	76.42	.	7.94E+00	.
6205	78.77	.	7.94E+00	.
6570	81.06	.	7.94E+00	.
6935	83.28	.	7.94E+00	.
7300	85.44	.	7.94E+00	.

APPENDIX 4

FIGURE A-1

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 1
WASTE=ALKALINE PERMANGANATE (AP)

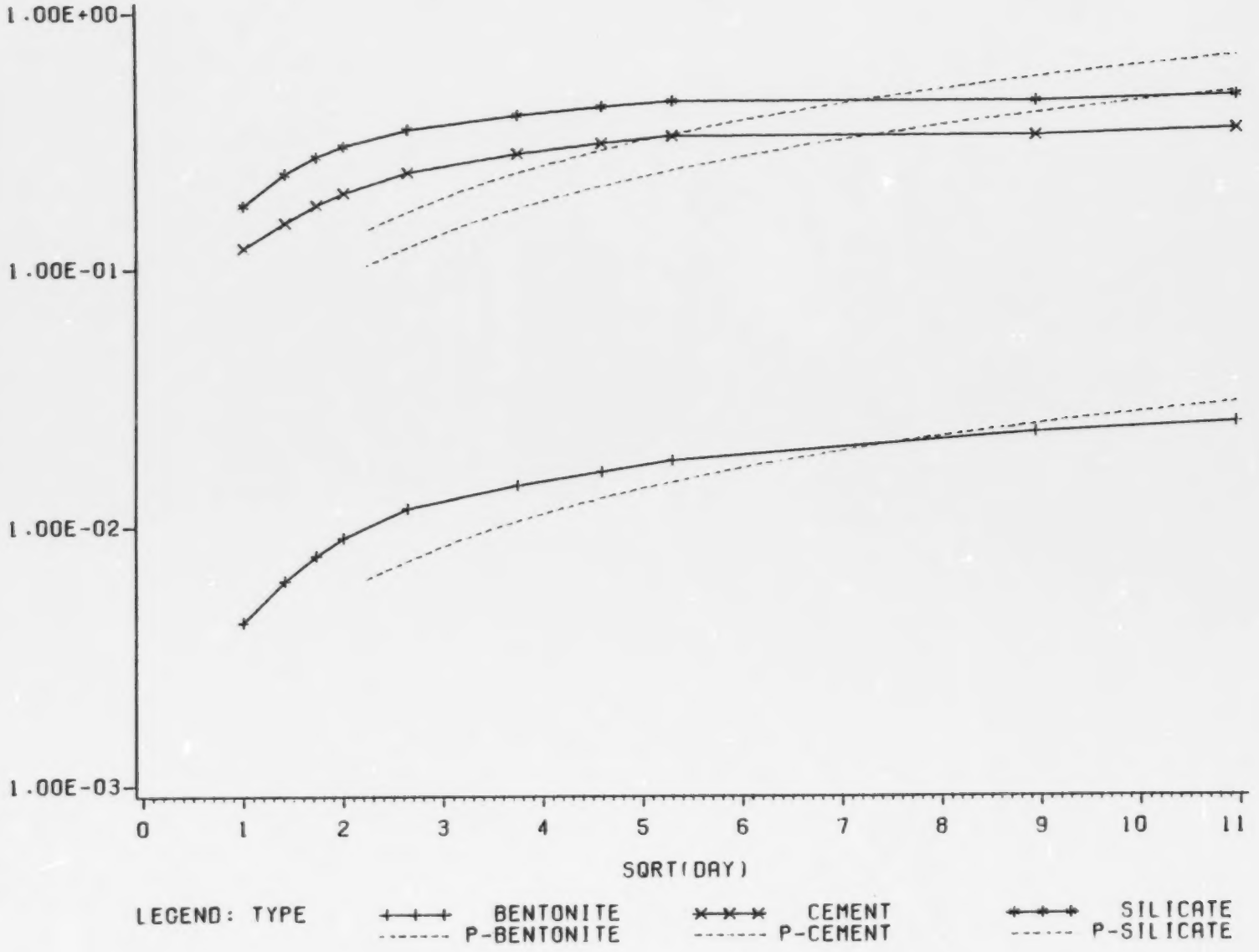
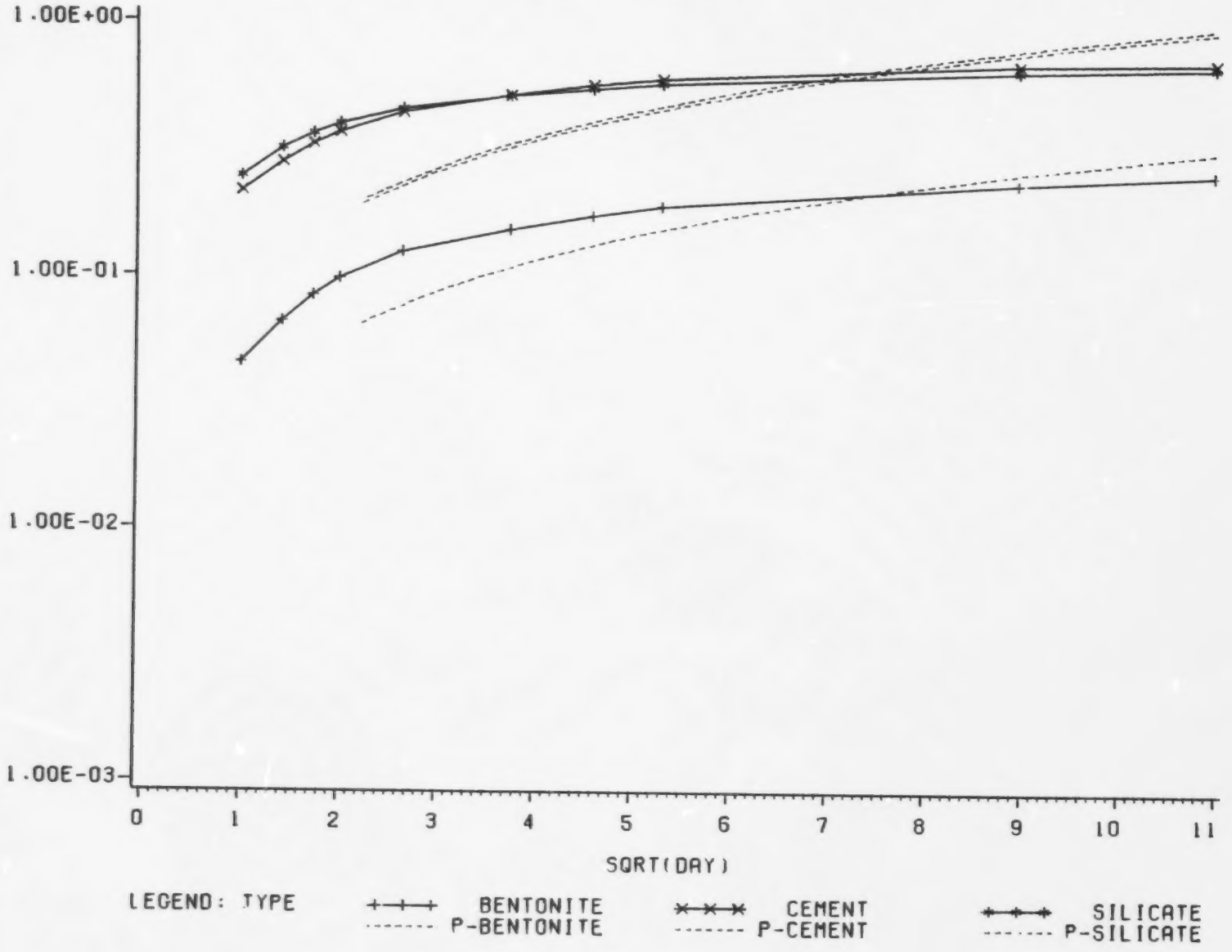


FIGURE 2-1

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 1
WASTE=TURCO 4512



84-209

FIGURE 3-1

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 1
WASTE=TURCO 4521A

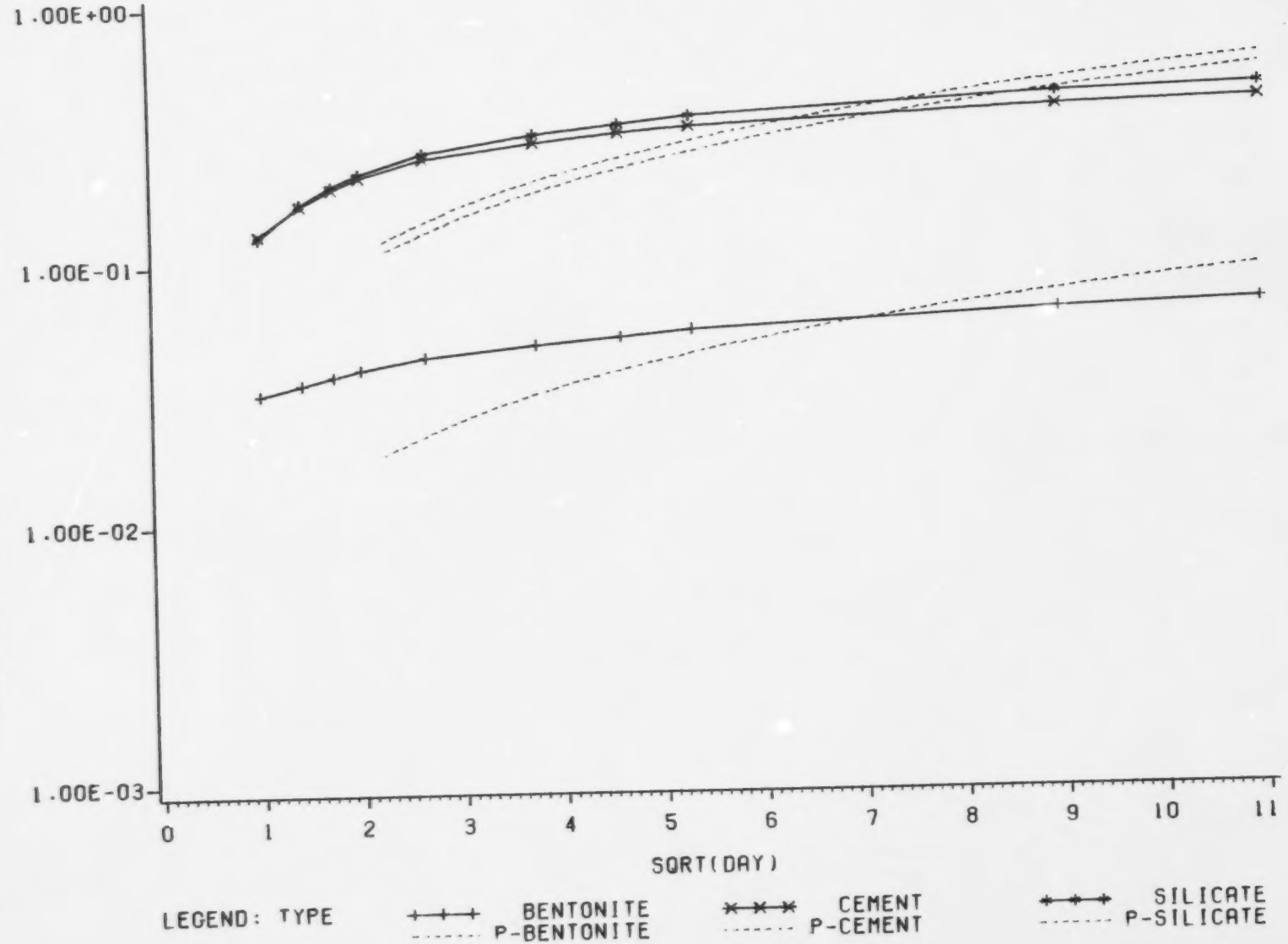
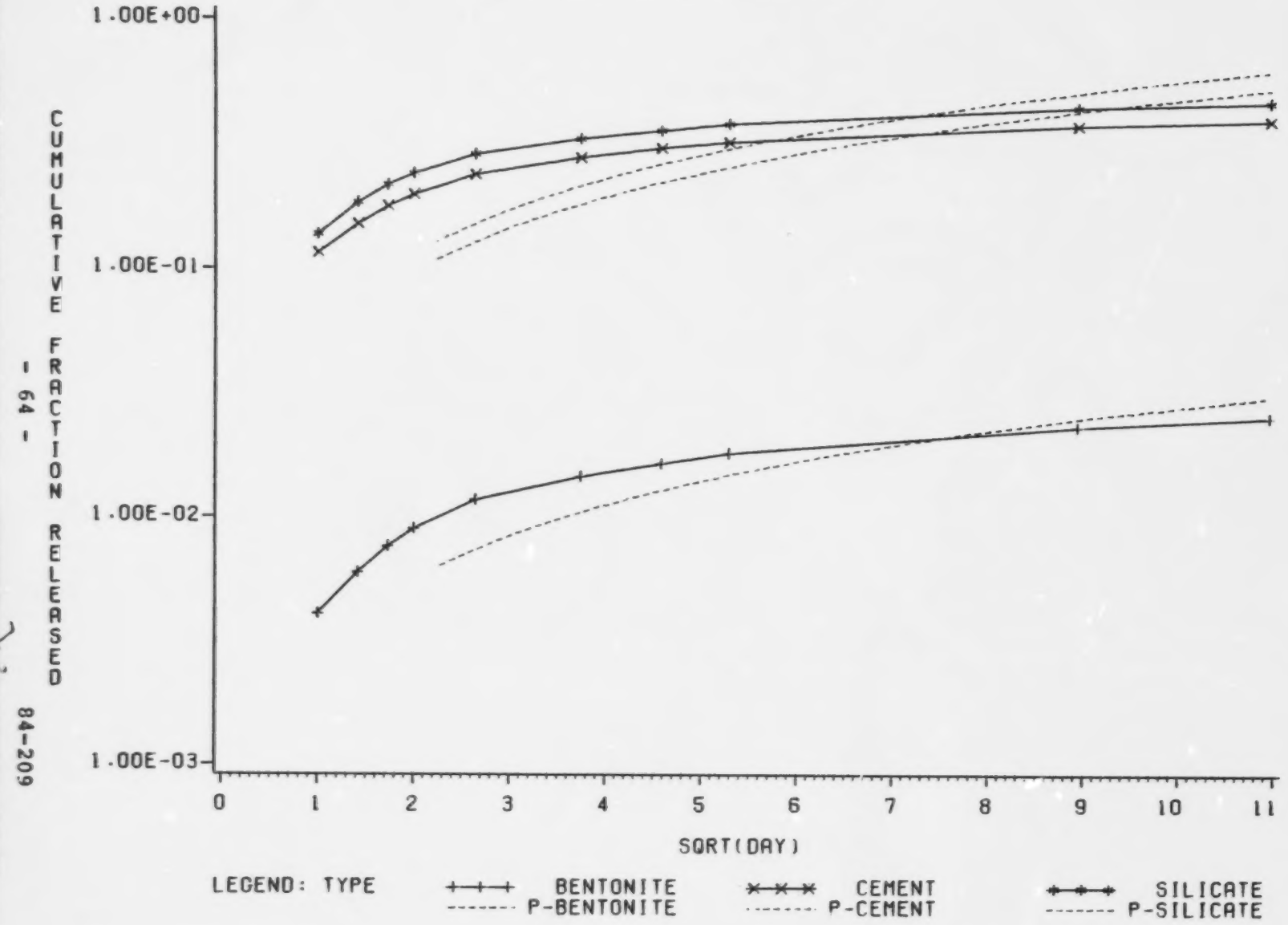


FIGURE 4-1

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 1

WASTE=PEROXIDE BICARBONATE (PB)

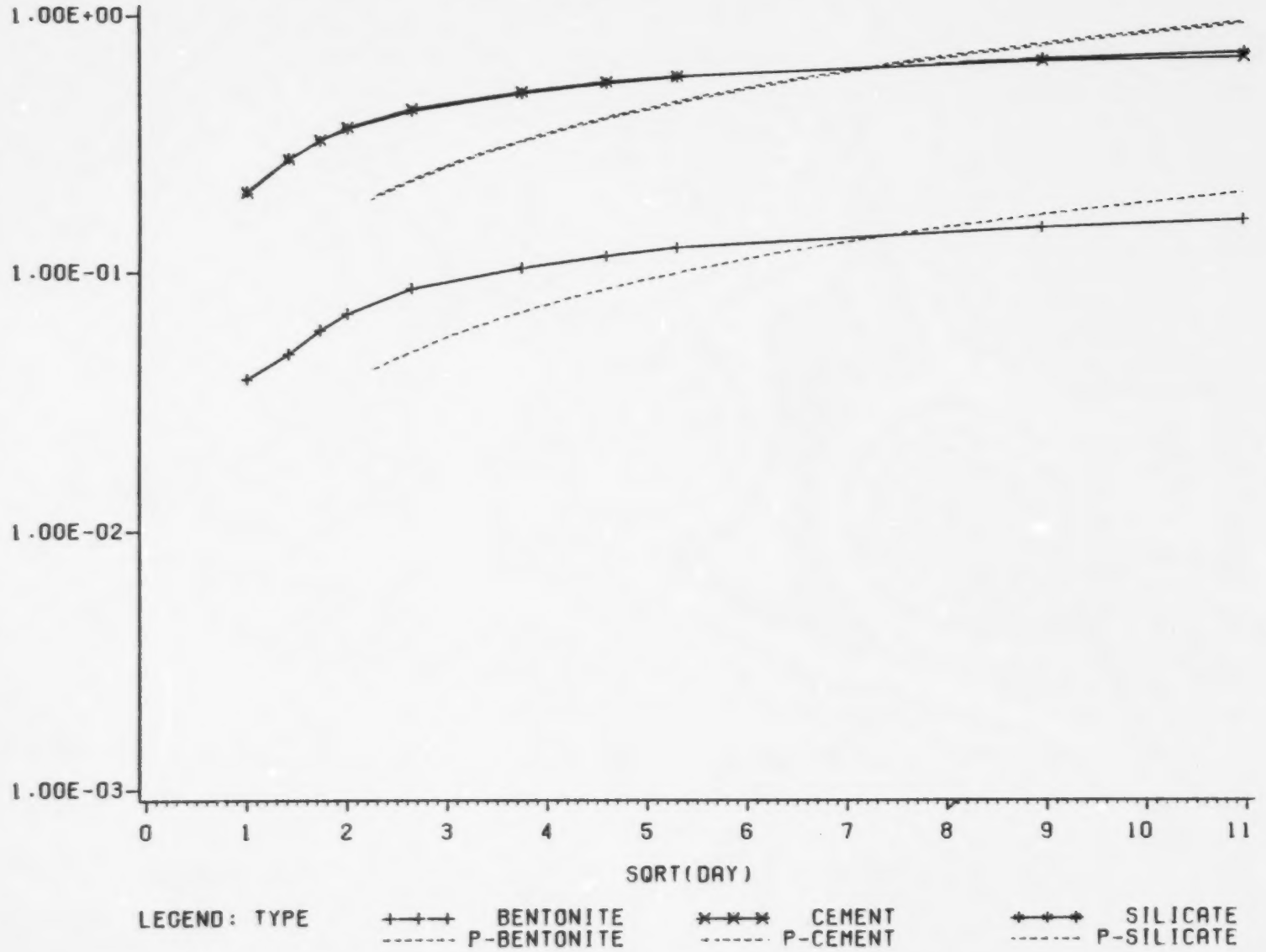


84-209

FIGURE 5-1

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 1
WASTE=POTASSIUM PERSULFATE (PP)



APPENDIX 5

FIGURE 1-1A

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 1AADJUSTED FOR RADIOACTIVE DECAY
WASTE=ALKALINE PERMANGANATE (AP)

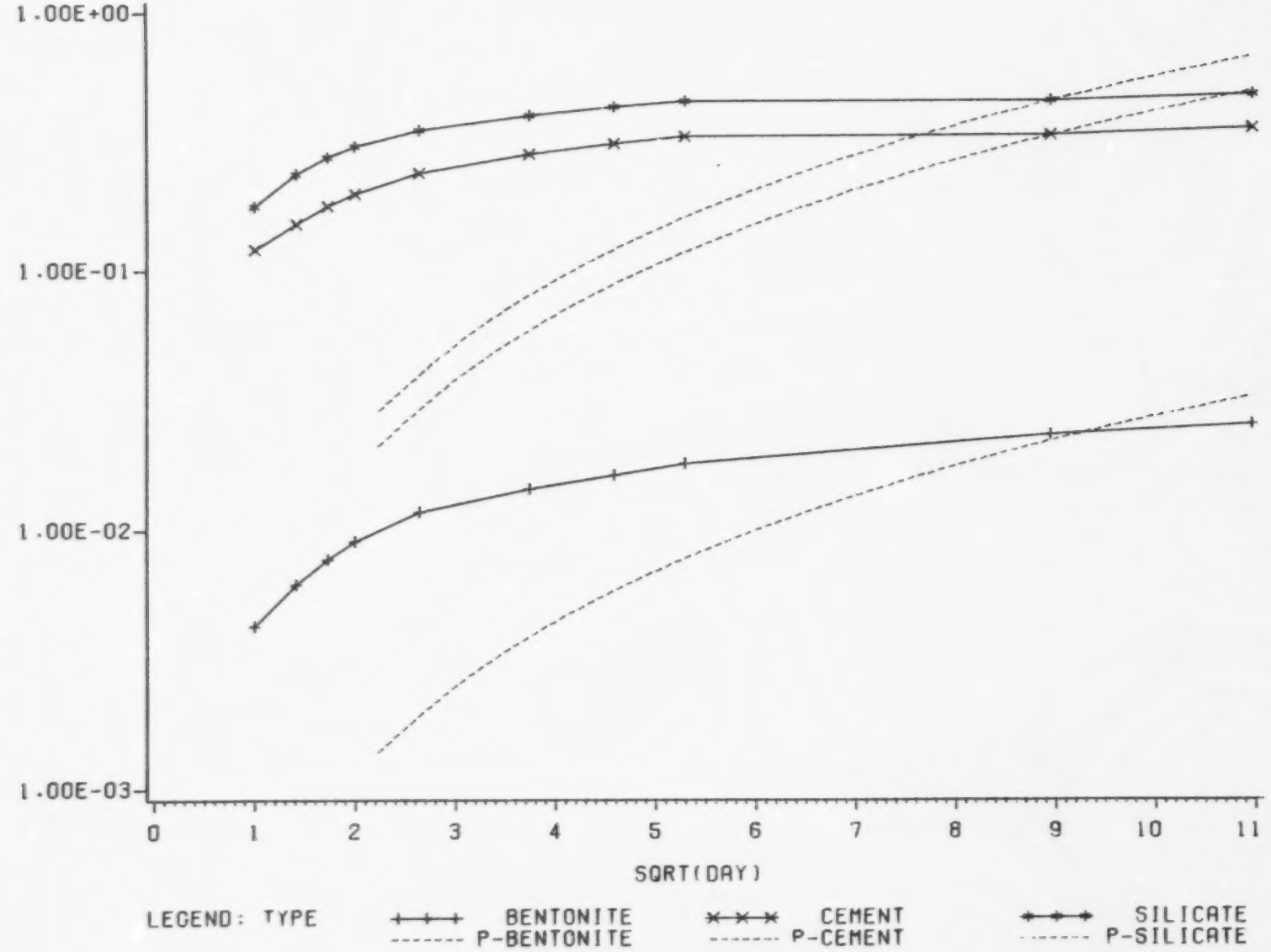


FIGURE 2-1A

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 1A ADJUSTED FOR RADIOACTIVE DECAY
WASTE=TURCO 4512

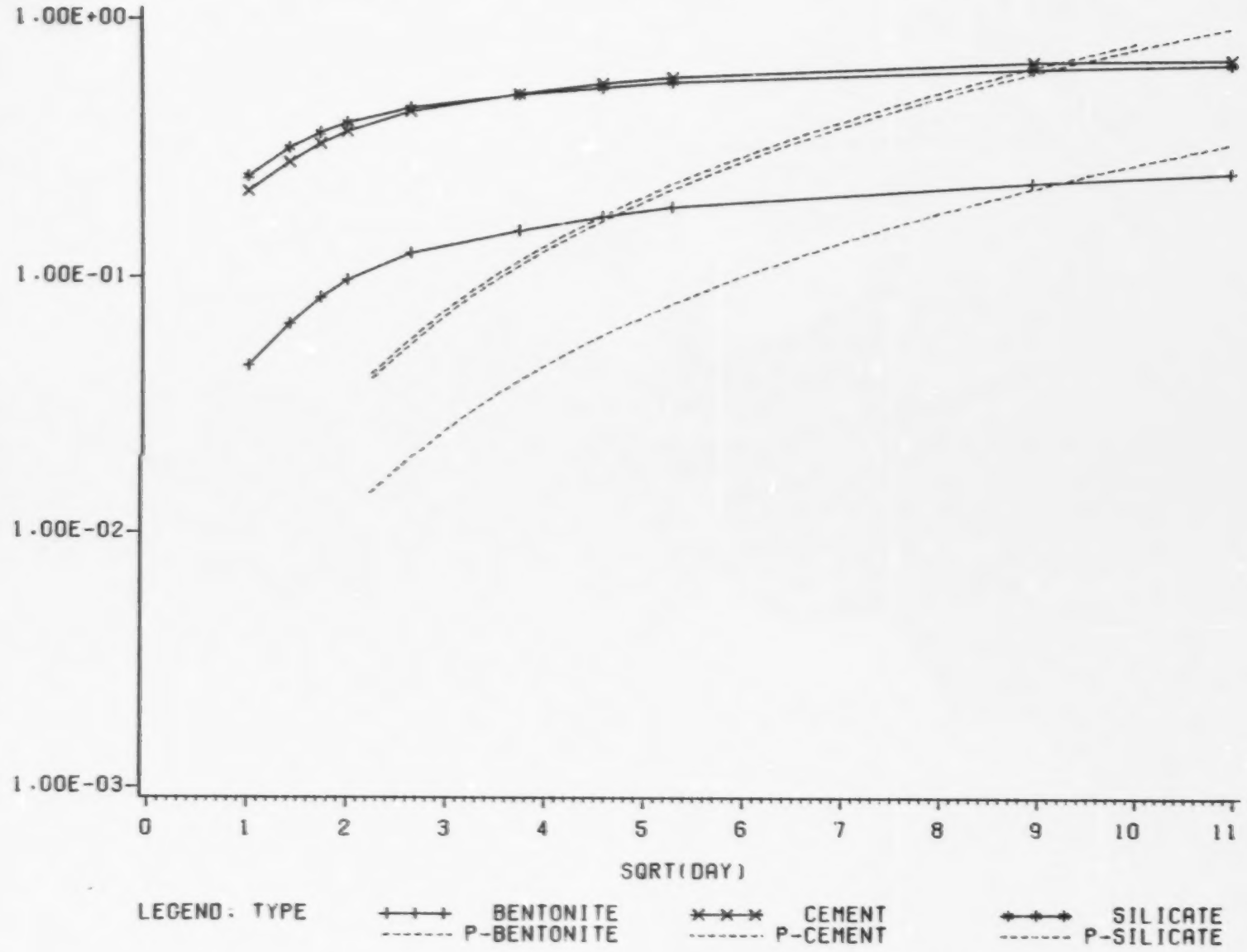


FIGURE 3-1A

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL1A ADJUSTED FOR RADIOACTIVE DECAY
WASTE=TURCO 4521A

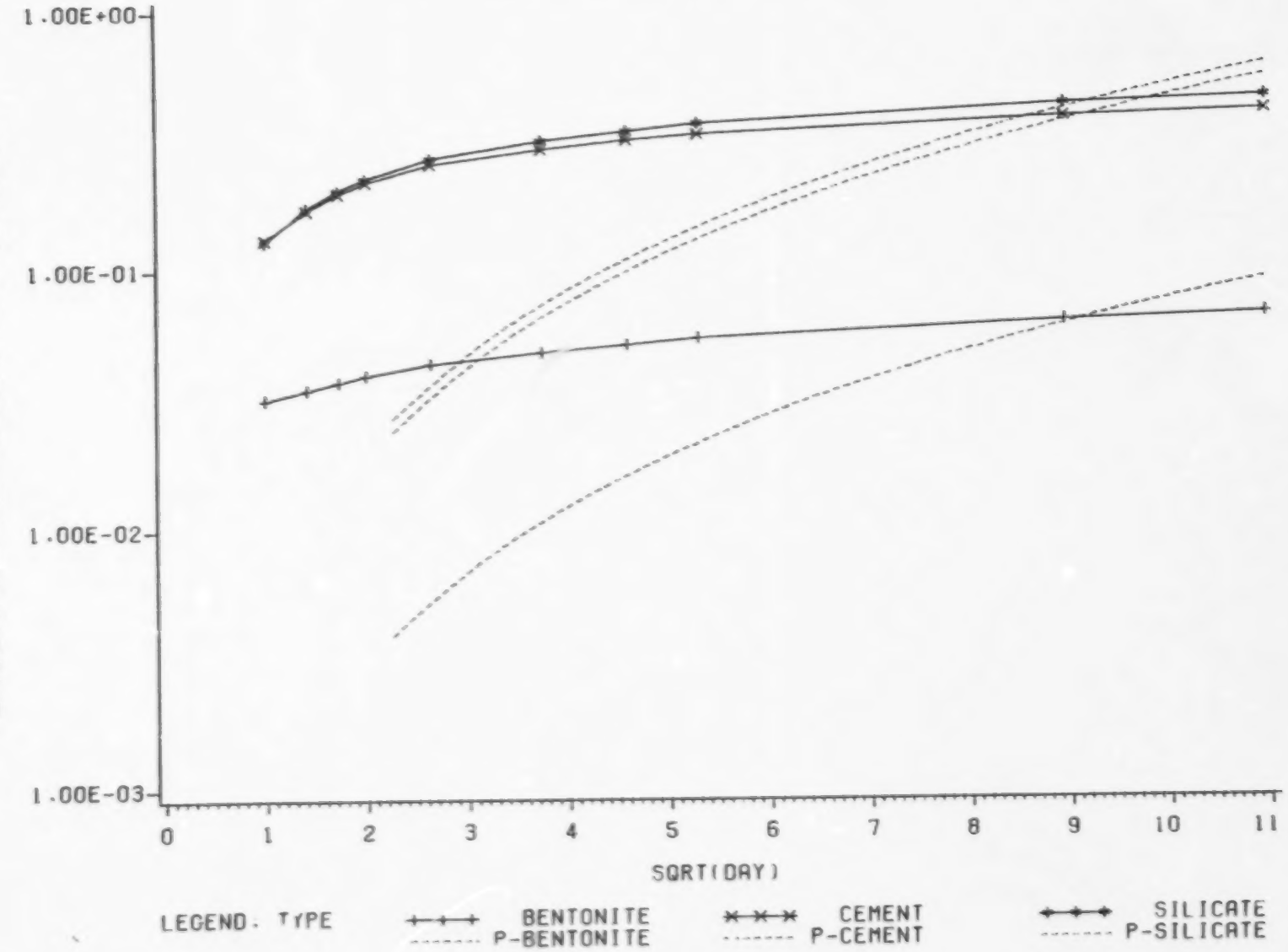


FIGURE 4-1A

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL1A ADJUSTED FOR RADIOACTIVE DECAY
WASTE=PEROXIDE BICARBONATE (PB)

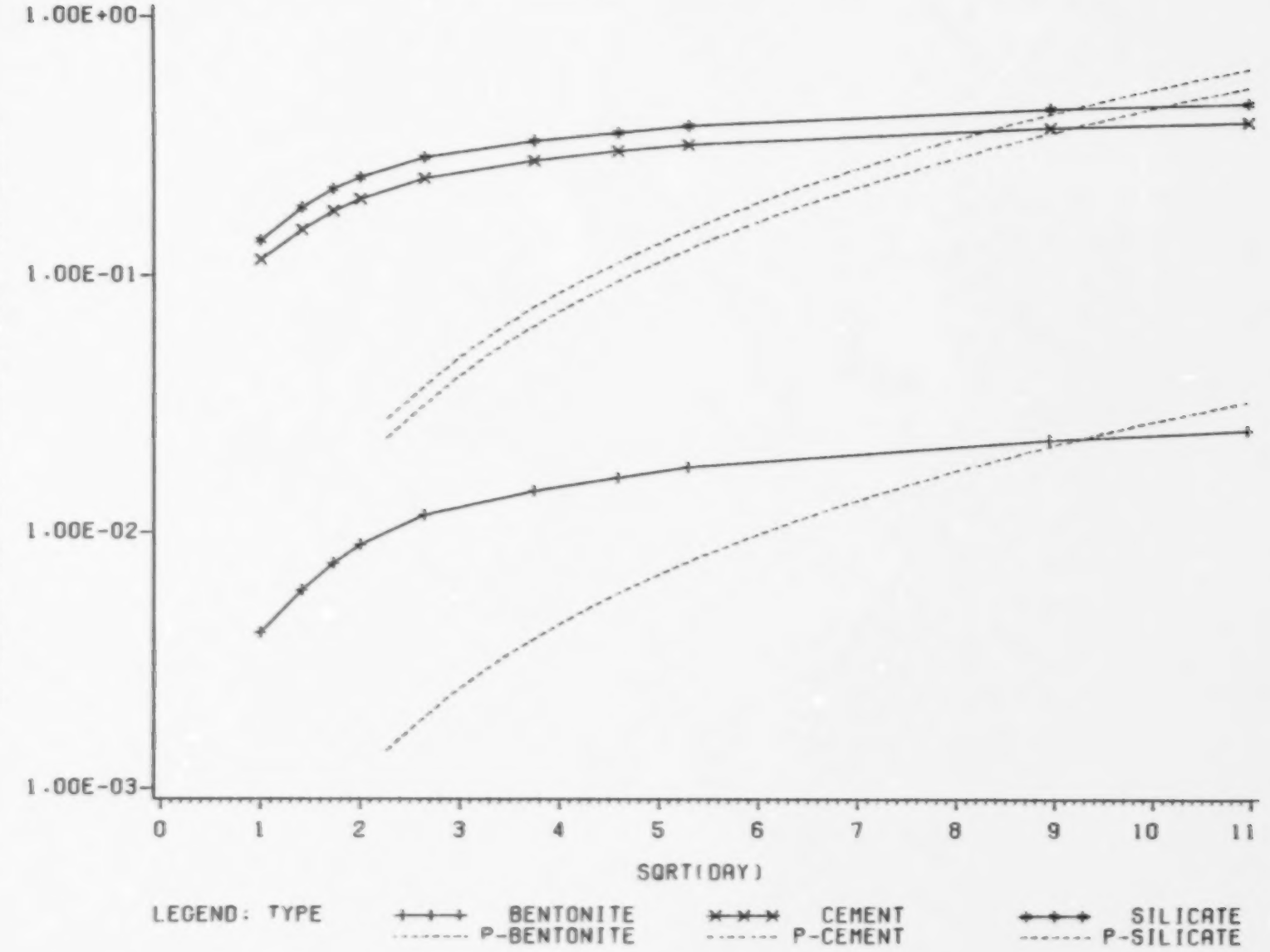
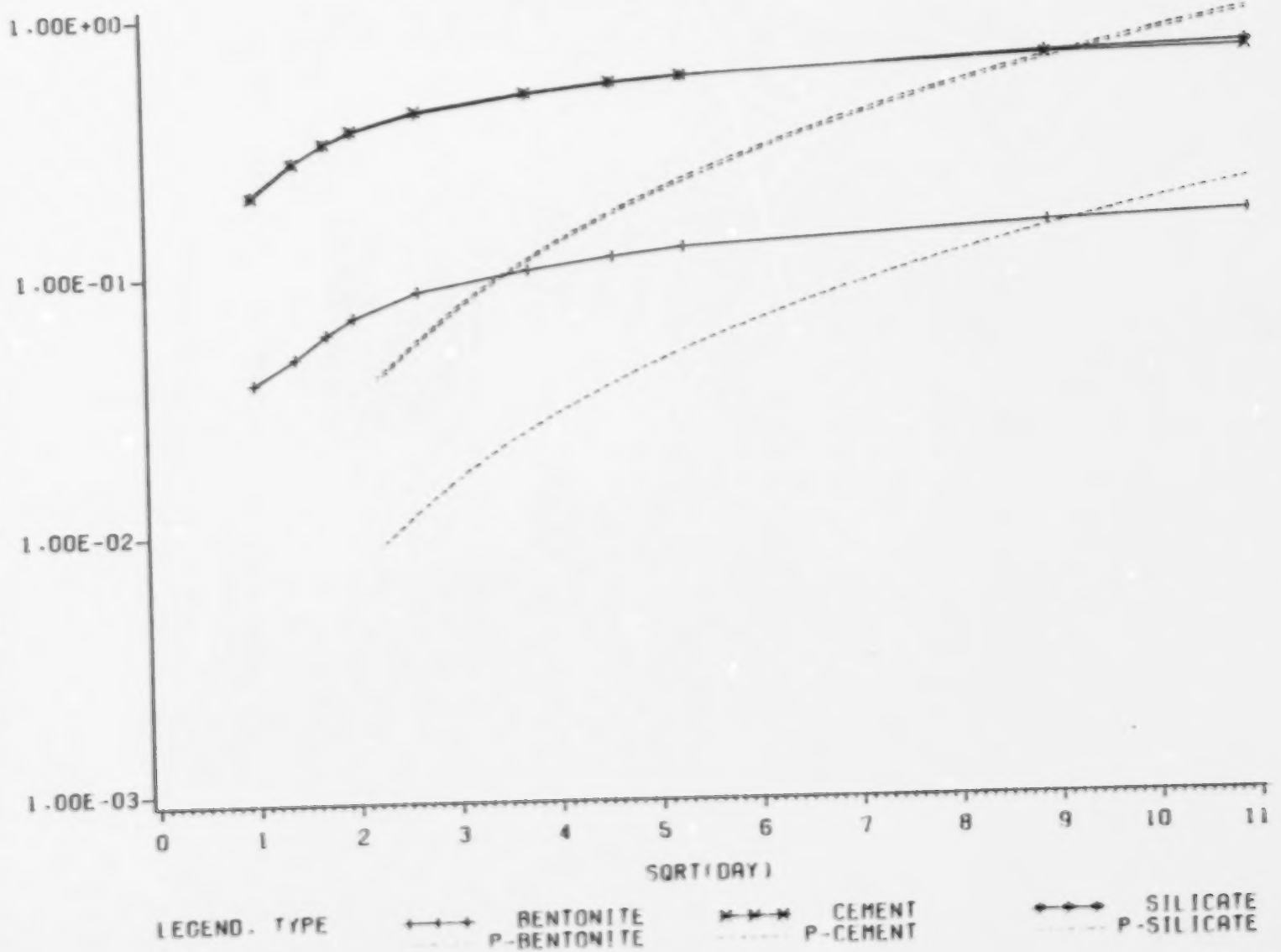


FIGURE 5-1A

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 1A ADJUSTED FOR RADIOACTIVE DECAY
WASTE=POTASSIUM PERSULFATE (PP)



APPENDIX 6

Table 1-2

Predicted and Actual Releases from ALKALINE PERMANGANATE (AP) using Model 2

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 40 ml AP AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.21E-01	1.80E-01	-5.92E-02
2	1.41	1.53E-01	1.90E-01	-3.65E-02
3	1.73	1.79E-01	1.97E-01	-1.84E-02
4	2.00	2.00E-01	2.03E-01	-3.02E-03
7	2.65	2.42E-01	2.18E-01	2.38E-02
14	3.74	2.86E-01	2.43E-01	4.31E-02
21	4.58	3.15E-01	2.62E-01	5.23E-02
28	5.29	3.36E-01	2.78E-01	5.81E-02
80	8.94	3.43E-01	3.62E-01	-1.83E-02
120	10.95	3.66E-01	4.08E-01	-4.19E-02
365	19.10	.	5.94E-01	.
730	27.02	.	7.74E-01	.
1095	33.09	.	9.13E-01	.
1460	38.21	.	1.03E+00	.
1825	42.72	.	1.13E+00	.
2190	46.80	.	1.23E+00	.
2555	50.55	.	1.31E+00	.
2920	54.04	.	1.39E+00	.
3285	57.31	.	1.47E+00	.
3650	60.42	.	1.54E+00	.
4015	63.36	.	1.60E+00	.
4380	66.18	.	1.67E+00	.
4745	68.88	.	1.73E+00	.
5110	71.48	.	1.79E+00	.
5475	73.99	.	1.85E+00	.
5840	76.42	.	1.90E+00	.
6205	78.77	.	1.96E+00	.
6570	81.06	.	2.01E+00	.
6935	83.28	.	2.06E+00	.
7300	85.44	.	2.11E+00	.

Data are not corrected for radioactive decay

Table 2-2

Predicted and Actual Releases from ALKALINE PERMANGANATE (AP) using Model 2

Matrix : PC-30 & BENTONITE

Waste form composition: 44 ml AP, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	4.30E-03	6.95E-03	-2.65E-03
2	1.41	6.21E-03	7.83E-03	-1.61E-03
3	1.73	7.77E-03	8.50E-03	-7.34E-04
4	2.00	9.11E-03	9.07E-03	4.54E-05
7	2.65	1.18E-02	1.04E-02	1.37E-03
14	3.74	1.45E-02	1.28E-02	1.80E-03
21	4.58	1.65E-02	1.45E-02	1.93E-03
28	5.29	1.81E-02	1.60E-02	2.09E-03
80	8.94	2.36E-02	2.38E-02	-1.54E-04
120	10.95	2.59E-02	2.80E-02	-2.08E-03
365	19.10	.	4.53E-02	.
730	27.02	.	6.20E-02	.
1095	33.09	.	7.49E-02	.
1460	38.21	.	8.57E-02	.
1825	42.72	.	9.52E-02	.
2190	46.80	.	1.04E-01	.
2555	50.55	.	1.12E-01	.
2920	54.04	.	1.19E-01	.
3285	57.31	.	1.26E-01	.
3650	60.42	.	1.33E-01	.
4015	63.36	.	1.39E-01	.
4380	66.18	.	1.45E-01	.
4745	68.88	.	1.51E-01	.
5110	71.48	.	1.56E-01	.
5475	73.99	.	1.61E-01	.
5840	76.42	.	1.67E-01	.
6205	78.77	.	1.72E-01	.
6570	81.06	.	1.76E-01	.
6935	83.28	.	1.81E-01	.
7300	85.44	.	1.86E-01	.

Data are not corrected for radioactive decay

Table 3-2

Predicted and Actual Releases from ALKALINE PERMANGANATE (AP) using Model 2

Matrix : PC-30 & SILICATE
Waste form composition: 44 ml AP, 100 g PORTLAND TYPE 30 CEMENT, AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.78E-01	2.72E-01	-9.48E-02
2	1.41	2.38E-01	2.84E-01	-4.61E-02
3	1.73	2.77E-01	2.93E-01	-1.56E-02
4	2.00	3.05E-01	3.00E-01	5.53E-03
7	2.65	3.55E-01	3.18E-01	3.76E-02
14	3.74	4.05E-01	3.48E-01	5.71E-02
21	4.58	4.36E-01	3.71E-01	6.54E-02
28	5.29	4.59E-01	3.90E-01	6.84E-02
80	8.94	4.65E-01	4.90E-01	-2.49E-02
120	10.95	4.93E-01	5.45E-01	-5.26E-02
365	19.10	.	7.69E-01	.
730	27.02	.	9.86E-01	.
1095	33.09	.	1.15E+00	.
1460	38.21	.	1.29E+00	.
1825	42.72	.	1.42E+00	.
2190	46.80	.	1.53E+00	.
2555	50.55	.	1.63E+00	.
2920	54.04	.	1.73E+00	.
3285	57.31	.	1.82E+00	.
3650	60.42	.	1.90E+00	.
4015	63.36	.	1.98E+00	.
4380	66.18	.	2.06E+00	.
4745	68.88	.	2.13E+00	.
5110	71.48	.	2.21E+00	.
5475	73.99	.	2.27E+00	.
5840	76.42	.	2.34E+00	.
6205	78.77	.	2.41E+00	.
6570	81.06	.	2.47E+00	.
6935	83.28	.	2.53E+00	.
7300	85.44	.	2.59E+00	.

Data are not corrected for radioactive decay

Table 4-2

Predicted and Actual Releases from TURCO 4512 using Model 2

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 60 ml TURCO 4512 AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.18E-01	3.22E-01	-1.04E-01
2	1.41	2.83E-01	3.42E-01	-5.85E-02
3	1.73	3.35E-01	3.57E-01	-2.29E-02
4	2.00	3.72E-01	3.70E-01	1.59E-03
7	2.65	4.45E-01	4.02E-01	4.30E-02
14	3.74	5.24E-01	4.55E-01	6.90E-02
21	4.58	5.74E-01	4.96E-01	7.81E-02
28	5.29	6.10E-01	5.31E-01	7.89E-02
80	8.94	7.05E-01	7.09E-01	-3.46E-03
120	10.95	7.25E-01	8.07E-01	-8.15E-02
365	19.10	.	1.20E+00	.
730	27.02	.	1.59E+00	.
1095	33.09	.	1.89E+00	.
1460	38.21	.	2.14E+00	.
1825	42.72	.	2.36E+00	.
2190	46.80	.	2.55E+00	.
2555	50.55	.	2.74E+00	.
2920	54.04	.	2.91E+00	.
3285	57.31	.	3.07E+00	.
3650	60.42	.	3.22E+00	.
4015	63.36	.	3.36E+00	.
4380	66.18	.	3.50E+00	.
4745	68.88	.	3.63E+00	.
5110	71.48	.	3.76E+00	.
5475	73.99	.	3.88E+00	.
5840	76.42	.	4.00E+00	.
6205	78.77	.	4.11E+00	.
6570	81.06	.	4.22E+00	.
6935	83.28	.	4.33E+00	.
7300	85.44	.	4.44E+00	.

Data are not corrected for radioactive decay

Table 5-2

Predicted and Actual Releases from TURCO 4512 using Model 2

Matrix : PC-30 & BENTONITE
Waste form composition: 60 ml TURCO 4512, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	4.52E-02	7.64E-02	-3.12E-02
2	1.41	6.62E-02	8.51E-02	-1.89E-02
3	1.73	8.36E-02	9.17E-02	-8.15E-03
4	2.00	9.85E-02	9.73E-02	1.15E-03
7	2.65	1.25E-01	1.11E-01	1.46E-02
14	3.74	1.54E-01	1.34E-01	1.99E-02
21	4.58	1.75E-01	1.51E-01	2.38E-02
28	5.29	1.92E-01	1.66E-01	2.55E-02
80	8.94	2.40E-01	2.43E-01	-2.86E-03
120	10.95	2.61E-01	2.85E-01	-2.39E-02
365	19.10	.	4.55E-01	.
730	27.02	.	6.20E-01	.
1095	33.09	.	7.47E-01	.
1460	38.21	.	8.54E-01	.
1825	42.72	.	9.49E-01	.
2190	46.80	.	1.03E+00	.
2555	50.55	.	1.11E+00	.
2920	54.04	.	1.19E+00	.
3285	57.31	.	1.25E+00	.
3650	60.42	.	1.32E+00	.
4015	63.36	.	1.38E+00	.
4380	66.18	.	1.44E+00	.
4745	68.88	.	1.50E+00	.
5110	71.48	.	1.55E+00	.
5475	73.99	.	1.60E+00	.
5840	76.42	.	1.65E+00	.
6205	78.77	.	1.70E+00	.
6570	81.06	.	1.75E+00	.
6935	83.28	.	1.80E+00	.
7300	85.44	.	1.84E+00	.

Data are not corrected for radioactive decay

Table 6-2

Predicted and Actual Releases from TURCO 4512 using Model 2

Matrix : PC-30 & SILICATE

Waste form composition: 60 ml TURCO 4512, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.48E-01	3.50E-01	-1.01E-01
2	1.41	3.21E-01	3.66E-01	-4.54E-02
3	1.73	3.67E-01	3.79E-01	-1.27E-02
4	2.00	4.01E-01	3.90E-01	1.14E-02
7	2.65	4.59E-01	4.16E-01	4.26E-02
14	3.74	5.18E-01	4.60E-01	5.81E-02
21	4.58	5.54E-01	4.94E-01	5.96E-02
28	5.29	5.80E-01	5.23E-01	5.73E-02
80	8.94	6.60E-01	6.70E-01	-1.04E-02
120	10.95	6.92E-01	7.52E-01	-5.92E-02
365	19.10	.	1.08E+00	.
730	27.02	.	1.40E+00	.
1095	33.09	.	1.65E+00	.
1460	38.21	.	1.85E+00	.
1825	42.72	.	2.03E+00	.
2190	46.80	.	2.20E+00	.
2555	50.55	.	2.35E+00	.
2920	54.04	.	2.49E+00	.
3285	57.31	.	2.62E+00	.
3650	60.42	.	2.75E+00	.
4015	63.36	.	2.87E+00	.
4380	66.18	.	2.98E+00	.
4745	68.88	.	3.09E+00	.
5110	71.48	.	3.20E+00	.
5475	73.99	.	3.30E+00	.
5840	76.42	.	3.40E+00	.
6205	78.77	.	3.49E+00	.
6570	81.06	.	3.58E+00	.
6935	83.28	.	3.67E+00	.
7300	85.44	.	3.76E+00	.

Data are not corrected for radioactive decay

Table 7-2

Predicted and Actual Releases from TURCO 4521A using Model 2

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 40 ml TURCO 4521A AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.32E-01	1.89E-01	-5.69E-02
2	1.41	1.71E-01	2.00E-01	-2.87E-02
3	1.73	1.99E-01	2.08E-01	-9.26E-03
4	2.00	2.20E-01	2.15E-01	4.63E-03
7	2.65	2.57E-01	2.33E-01	2.50E-02
14	3.74	2.96E-01	2.61E-01	3.48E-02
21	4.58	3.20E-01	2.84E-01	3.67E-02
28	5.29	3.38E-01	3.02E-01	3.53E-02
80	8.94	3.95E-01	3.99E-01	-4.09E-03
120	10.95	4.14E-01	4.52E-01	-3.75E-02
365	19.10	.	6.67E-01	.
730	27.02	.	8.76E-01	.
1095	33.09	.	1.04E+00	.
1460	38.21	.	1.17E+00	.
1825	42.72	.	1.29E+00	.
2190	46.80	.	1.40E+00	.
2555	50.55	.	1.50E+00	.
2920	54.04	.	1.59E+00	.
3285	57.31	.	1.68E+00	.
3650	60.42	.	1.76E+00	.
4015	63.36	.	1.83E+00	.
4380	66.18	.	1.91E+00	.
4745	68.88	.	1.98E+00	.
5110	71.48	.	2.05E+00	.
5475	73.99	.	2.12E+00	.
5840	76.42	.	2.18E+00	.
6205	78.77	.	2.24E+00	.
6570	81.06	.	2.30E+00	.
6935	83.28	.	2.36E+00	.
7300	85.44	.	2.42E+00	.

Data are not corrected for radioactive decay

84-209

Table 8-2

Predicted and Actual Releases from TURCO 4521A using Model 2

Matrix : PC-30 & BENTONITE

Waste form composition: 44 ml TURCO 4521A, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	3.18E-02	3.60E-02	-4.20E-03
2	1.41	3.49E-02	3.75E-02	-2.60E-03
3	1.73	3.73E-02	3.86E-02	-1.27E-03
4	2.00	3.95E-02	3.96E-02	-2.41E-05
7	2.65	4.39E-02	4.19E-02	2.08E-03
14	3.74	4.86E-02	4.58E-02	2.79E-03
21	4.58	5.21E-02	4.88E-02	3.28E-03
28	5.29	5.49E-02	5.13E-02	3.57E-03
80	8.94	6.44E-02	6.43E-02	3.02E-05
120	10.95	6.78E-02	7.15E-02	-3.65E-03
365	19.10	.	1.01E-01	.
730	27.02	.	1.29E-01	.
1095	33.09	.	1.50E-01	.
1460	38.21	.	1.69E-01	.
1825	42.72	.	1.85E-01	.
2190	46.80	.	1.99E-01	.
2555	50.55	.	2.13E-01	.
2920	54.04	.	2.25E-01	.
3285	57.31	.	2.37E-01	.
3650	60.42	.	2.48E-01	.
4015	63.36	.	2.58E-01	.
4380	66.18	.	2.68E-01	.
4745	68.88	.	2.78E-01	.
5110	71.48	.	2.87E-01	.
5475	73.99	.	2.96E-01	.
5840	76.42	.	3.05E-01	.
6205	78.77	.	3.13E-01	.
6570	81.06	.	3.22E-01	.
6935	83.28	.	3.29E-01	.
7300	85.44	.	3.37E-01	.

Data are not corrected for radioactive decay

Table 9-2
Predicted and Actual Releases from TURCO 4521A using Model 2

Matrix : PC-30 & SILICATE
Waste form composition: 44 ml TURCO 4521A, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.30E-01	1.93E-01	-6.29E-02
2	1.41	1.75E-01	2.06E-01	-3.14E-02
3	1.73	2.06E-01	2.16E-01	-1.01E-02
4	2.00	2.28E-01	2.25E-01	2.98E-03
7	2.65	2.73E-01	2.45E-01	2.76E-02
14	3.74	3.19E-01	2.80E-01	3.82E-02
21	4.58	3.48E-01	3.07E-01	4.12E-02
28	5.29	3.71E-01	3.30E-01	4.12E-02
80	8.94	4.43E-01	4.46E-01	-3.78E-03
120	10.95	4.68E-01	5.11E-01	-4.29E-02
365	19.10	.	7.71E-01	.
730	27.02	.	1.02E+00	.
1095	33.09	.	1.22E+00	.
1460	38.21	.	1.38E+00	.
1825	42.72	.	1.52E+00	.
2190	46.80	.	1.65E+00	.
2555	50.55	.	1.77E+00	.
2920	54.04	.	1.89E+00	.
3285	57.31	.	1.99E+00	.
3650	60.42	.	2.09E+00	.
4015	63.36	.	2.18E+00	.
4380	66.18	.	2.27E+00	.
4745	68.88	.	2.36E+00	.
5110	71.48	.	2.44E+00	.
5475	73.99	.	2.52E+00	.
5840	76.42	.	2.60E+00	.
6205	78.77	.	2.68E+00	.
6570	81.06	.	2.75E+00	.
6935	83.28	.	2.82E+00	.
7300	85.44	.	2.89E+00	.

Data are not corrected for radioactive decay

Table 10-2

Predicted and Actual Releases from PEROXIDE BICARBONATE (PB) using Model 2

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 40 ml PB AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.17E-01	1.72E-01	-5.49E-02
2	1.41	1.52E-01	1.83E-01	-3.03E-02
3	1.73	1.79E-01	1.91E-01	-1.24E-02
4	2.00	2.00E-01	1.99E-01	1.73E-03
7	2.65	2.42E-01	2.16E-01	2.52E-02
14	3.74	2.83E-01	2.46E-01	3.73E-02
21	4.58	3.09E-01	2.69E-01	3.95E-02
28	5.29	3.26E-01	2.88E-01	3.79E-02
80	8.94	3.83E-01	3.88E-01	-4.69E-03
120	10.95	4.03E-01	4.43E-01	-3.93E-02
365	19.10	.	6.65E-01	.
730	27.02	.	8.80E-01	.
1095	33.09	.	1.05E+00	.
1460	38.21	.	1.19E+00	.
1825	42.72	.	1.31E+00	.
2190	46.80	.	1.42E+00	.
2555	50.55	.	1.52E+00	.
2920	54.04	.	1.62E+00	.
3285	57.31	.	1.71E+00	.
3650	60.42	.	1.79E+00	.
4015	63.36	.	1.87E+00	.
4380	66.18	.	1.95E+00	.
4745	68.88	.	2.02E+00	.
5110	71.48	.	2.09E+00	.
5475	73.99	.	2.16E+00	.
5840	76.42	.	2.23E+00	.
6205	78.77	.	2.29E+00	.
6570	81.06	.	2.35E+00	.
6935	83.28	.	2.41E+00	.
7300	85.44	.	2.47E+00	.

Data are not corrected for radioactive decay

Table 11-2

Predicted and Actual Releases from PEROXIDE BICARBONATE (PB) using Model 2

Matrix : PC-30 & BENTONITE
Waste form composition: 44 ml PB, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	4.06E-03	6.89E-03	-2.83E-03
2	1.41	5.99E-03	7.75E-03	-1.76E-03
3	1.73	7.62E-03	8.42E-03	-8.01E-04
4	2.00	8.99E-03	8.98E-03	9.73E-06
7	2.65	1.18E-02	1.03E-02	1.45E-03
14	3.74	1.46E-02	1.26E-02	1.96E-03
21	4.58	1.65E-02	1.44E-02	2.13E-03
28	5.29	1.81E-02	1.59E-02	2.27E-03
80	8.94	2.33E-02	2.35E-02	-1.81E-04
120	10.95	2.54E-02	2.77E-02	-2.25E-03
365	19.10	.	4.47E-02	.
730	27.02	.	6.13E-02	.
1095	33.09	.	7.40E-02	.
1460	38.21	.	8.46E-02	.
1825	42.72	.	9.41E-02	.
2190	46.80	.	1.03E-01	.
2555	50.55	.	1.10E-01	.
2920	54.04	.	1.18E-01	.
3285	57.31	.	1.25E-01	.
3650	60.42	.	1.31E-01	.
4015	63.36	.	1.37E-01	.
4380	66.18	.	1.43E-01	.
4745	68.88	.	1.49E-01	.
5110	71.48	.	1.54E-01	.
5475	73.99	.	1.59E-01	.
5840	76.42	.	1.65E-01	.
6205	78.77	.	1.69E-01	.
6570	81.06	.	1.74E-01	.
6935	83.28	.	1.79E-01	.
7300	85.44	.	1.83E-01	.

Data are not corrected for radioactive decay

Table 12-2

Predicted and Actual Releases from PEROXIDE BICARBONATE (PB) using Model 2

Matrix : PC-30 & SILICATE
Waste form composition: 44 ml PB, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.38E-01	2.07E-01	-6.83E-02
2	1.41	1.86E-01	2.20E-01	-3.42E-02
3	1.73	2.18E-01	2.30E-01	-1.19E-02
4	2.00	2.43E-01	2.38E-01	4.71E-03
7	2.65	2.90E-01	2.59E-01	3.09E-02
14	3.74	3.35E-01	2.93E-01	4.19E-02
21	4.58	3.64E-01	3.20E-01	4.40E-02
28	5.29	3.86E-01	3.43E-01	4.34E-02
80	8.94	4.52E-01	4.58E-01	-6.01E-03
120	10.95	4.77E-01	5.22E-01	-4.46E-02
365	19.10	.	7.80E-01	.
730	27.02	.	1.03E+00	.
1095	33.09	.	1.22E+00	.
1460	38.21	.	1.38E+00	.
1825	42.72	.	1.53E+00	.
2190	46.80	.	1.66E+00	.
2555	50.55	.	1.77E+00	.
2920	54.04	.	1.89E+00	.
3285	57.31	.	1.99E+00	.
3650	60.42	.	2.09E+00	.
4015	63.36	.	2.18E+00	.
4380	66.18	.	2.27E+00	.
4745	68.88	.	2.35E+00	.
5110	71.48	.	2.44E+00	.
5475	73.99	.	2.52E+00	.
5840	76.42	.	2.59E+00	.
6205	78.77	.	2.67E+00	.
6570	81.06	.	2.74E+00	.
6935	83.28	.	2.81E+00	.
7300	85.44	.	2.88E+00	.

Data are not corrected for radioactive decay

Table 13-2
Predicted and Actual Releases from POTASSIUM PERSULFATE (PP) using Model 2

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 70 ml PP AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.06E-01	3.14E-01	-1.09E-01
2	1.41	2.78E-01	3.34E-01	-5.59E-02
3	1.73	3.29E-01	3.49E-01	-1.99E-02
4	2.00	3.69E-01	3.61E-01	7.57E-03
7	2.65	4.38E-01	3.91E-01	4.69E-02
14	3.74	5.10E-01	4.42E-01	6.75E-02
21	4.58	5.55E-01	4.81E-01	7.33E-02
28	5.29	5.87E-01	5.15E-01	7.22E-02
80	8.94	6.76E-01	6.85E-01	-9.26E-03
120	10.95	7.05E-01	7.79E-01	-7.34E-02
365	19.10	.	1.16E+00	.
730	27.02	.	1.53E+00	.
1095	33.09	.	1.81E+00	.
1460	38.21	.	2.05E+00	.
1825	42.72	.	2.26E+00	.
2190	46.80	.	2.45E+00	.
2555	50.55	.	2.63E+00	.
2920	54.04	.	2.79E+00	.
3285	57.31	.	2.94E+00	.
3650	60.42	.	3.09E+00	.
4015	63.36	.	3.22E+00	.
4380	66.18	.	3.35E+00	.
4745	68.88	.	3.48E+00	.
5110	71.48	.	3.60E+00	.
5475	73.99	.	3.72E+00	.
5840	76.42	.	3.83E+00	.
6205	78.77	.	3.94E+00	.
6570	81.06	.	4.05E+00	.
6935	83.28	.	4.15E+00	.
7300	85.44	.	4.25E+00	.

Data are not corrected for radioactive decay

Table 14-2

Predicted and Actual Releases from POTASSIUM PERSULFATE (PP) using Model 2

Matrix : PC-30 & BENTONITE
Waste form composition: 70 ml PP, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	3.88E-02	5.75E-02	-1.87E-02
2	1.41	4.86E-02	6.26E-02	-1.40E-02
3	1.73	6.01E-02	6.64E-02	-6.34E-03
4	2.00	6.98E-02	6.97E-02	1.06E-04
7	2.65	8.74E-02	7.76E-02	9.84E-03
14	3.74	1.05E-01	9.09E-02	1.41E-02
21	4.58	1.17E-01	1.01E-01	1.60E-02
28	5.29	1.27E-01	1.10E-01	1.69E-02
80	8.94	1.52E-01	1.54E-01	-1.99E-03
120	10.95	1.63E-01	1.79E-01	-1.59E-02
365	19.10	.	2.78E-01	.
730	27.02	.	3.74E-01	.
1095	33.09	.	4.48E-01	.
1460	38.21	.	5.11E-01	.
1825	42.72	.	5.66E-01	.
2190	46.80	.	6.15E-01	.
2555	50.55	.	6.61E-01	.
2920	54.04	.	7.03E-01	.
3285	57.31	.	7.43E-01	.
3650	60.42	.	7.81E-01	.
4015	63.36	.	8.17E-01	.
4380	66.18	.	8.51E-01	.
4745	68.88	.	8.84E-01	.
5110	71.48	.	9.16E-01	.
5475	73.99	.	9.47E-01	.
5840	76.42	.	9.76E-01	.
6205	78.77	.	1.00E+00	.
6570	81.06	.	1.03E+00	.
6935	83.28	.	1.06E+00	.
7300	85.44	.	1.09E+00	.

Data are not corrected for radioactive decay

Table 15-2

Predicted and Actual Releases from POTASSIUM PERSULFATE (PP) using Model 2

Matrix : PC-30 & SILICATE
Waste form composition: 70 ml PP, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.08E-01	3.07E-01	-9.97E-02
2	1.41	2.79E-01	3.28E-01	-4.89E-02
3	1.73	3.28E-01	3.44E-01	-1.52E-02
4	2.00	3.66E-01	3.57E-01	9.28E-03
7	2.65	4.29E-01	3.89E-01	4.00E-02
14	3.74	5.04E-01	4.44E-01	6.06E-02
21	4.58	5.51E-01	4.85E-01	6.51E-02
28	5.29	5.84E-01	5.21E-01	6.31E-02
80	8.94	6.89E-01	7.02E-01	-1.30E-02
120	10.95	7.41E-01	8.02E-01	-6.14E-02
365	19.10	.	1.21E+00	.
730	27.02	.	1.60E+00	.
1095	33.09	.	1.90E+00	.
1460	38.21	.	2.16E+00	.
1825	42.72	.	2.38E+00	.
2190	46.80	.	2.59E+00	.
2555	50.55	.	2.77E+00	.
2920	54.04	.	2.95E+00	.
3285	57.31	.	3.11E+00	.
3650	60.42	.	3.26E+00	.
4015	63.36	.	3.41E+00	.
4380	66.18	.	3.55E+00	.
4745	68.88	.	3.68E+00	.
5110	71.48	.	3.81E+00	.
5475	73.99	.	3.94E+00	.
5840	76.42	.	4.06E+00	.
6205	78.77	.	4.18E+00	.
6570	81.06	.	4.29E+00	.
6935	83.28	.	4.40E+00	.
7300	85.44	.	4.51E+00	.

Data are not corrected for radioactive decay

APPENDIX 7

Table 1-2A

Predicted and Actual Releases from ALKALINE PERMANGANATE (AP) using Model 2A
Corrected for radioactive decay

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 40 ml AP AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.21E-01	2.10E-01	-8.86E-02
2	1.41	1.53E-01	2.12E-01	-5.81E-02
3	1.73	1.79E-01	2.13E-01	-3.44E-02
4	2.00	2.00E-01	2.15E-01	-1.46E-02
7	2.65	2.42E-01	2.20E-01	2.21E-02
14	3.74	2.86E-01	2.31E-01	5.49E-02
21	4.58	3.15E-01	2.43E-01	7.18E-02
28	5.29	3.36E-01	2.54E-01	8.22E-02
80	8.94	3.43E-01	3.40E-01	3.82E-03
120	10.95	3.66E-01	4.05E-01	-3.91E-02
365	19.10	.	7.87E-01	.
730	27.02	.	1.25E+00	.
1095	33.09	.	1.54E+00	.
1460	38.21	.	1.69E+00	.
1825	42.72	.	1.75E+00	.
2190	46.80	.	1.77E+00	.
2555	50.55	.	1.78E+00	.
2920	54.04	.	1.78E+00	.
3285	57.31	.	1.78E+00	.
3650	60.42	.	1.78E+00	.
4015	63.36	.	1.78E+00	.
4380	66.18	.	1.78E+00	.
4745	68.88	.	1.78E+00	.
5110	71.48	.	1.78E+00	.
5475	73.99	.	1.78E+00	.
5840	76.42	.	1.78E+00	.
6205	78.77	.	1.78E+00	.
6570	81.06	.	1.78E+00	.
6935	83.28	.	1.78E+00	.
7300	85.44	.	1.78E+00	.

Table 2-2A

Predicted and Actual Releases from ALKALINE PERMANGANATE (AP) using Model 2A
Corrected for radioactive decay

Matrix : PC-30 & BENTONITE
Waste form composition: 44 ml AP, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	4.30E-03	9.38E-03	-5.08E-03
2	1.41	6.21E-03	9.54E-03	-3.33E-03
3	1.73	7.77E-03	9.70E-03	-1.94E-03
4	2.00	9.11E-03	9.87E-03	-7.58E-04
7	2.65	1.18E-02	1.04E-02	1.44E-03
14	3.74	1.45E-02	1.15E-02	3.04E-03
21	4.58	1.65E-02	1.27E-02	3.81E-03
28	5.29	1.81E-02	1.38E-02	4.32E-03
80	8.94	2.36E-02	2.23E-02	1.32E-03
120	10.95	2.59E-02	2.88E-02	-2.84E-03
365	19.10	.	6.67E-02	.
730	27.02	.	1.13E-01	.
1095	33.09	.	1.42E-01	.
1460	38.21	.	1.57E-01	.
1825	42.72	.	1.63E-01	.
2190	46.80	.	1.64E-01	.
2555	50.55	.	1.65E-01	.
2920	54.04	.	1.65E-01	.
3285	57.31	.	1.65E-01	.
3650	60.42	.	1.65E-01	.
4015	63.36	.	1.65E-01	.
4380	66.18	.	1.65E-01	.
4745	68.88	.	1.65E-01	.
5110	71.48	.	1.65E-01	.
5475	73.99	.	1.65E-01	.
5840	76.42	.	1.65E-01	.
6205	78.77	.	1.65E-01	.
6570	81.06	.	1.65E-01	.
6935	83.28	.	1.65E-01	.
7300	85.44	.	1.65E-01	.

Table 3-2A

Predicted and Actual Releases from ALKALINE PERMANGANATE (AP) using Model 2A
Corrected for radioactive decay

Matrix : PC-30 & SILICATE
Waste form composition: 44 ml AP, 100 g PORTLAND TYPE 30 CEMENT, AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.78E-01	3.08E-01	-1.31E-01
2	1.41	2.38E-01	3.10E-01	-7.27E-02
3	1.73	2.77E-01	3.12E-01	-3.54E-02
4	2.00	3.05E-01	3.14E-01	-8.86E-03
7	2.65	3.55E-01	3.20E-01	3.50E-02
14	3.74	4.05E-01	3.34E-01	7.10E-02
21	4.58	4.36E-01	3.47E-01	8.86E-02
28	5.29	4.59E-01	3.61E-01	9.74E-02
80	8.94	4.65E-01	4.63E-01	2.91E-03
120	10.95	4.93E-01	5.40E-01	-4.72E-02
365	19.10	.	9.93E-01	.
730	27.02	.	1.54E+00	.
1095	33.09	.	1.89E+00	.
1460	38.21	.	2.07E+00	.
1825	42.72	.	2.14E+00	.
2190	46.80	.	2.16E+00	.
2555	50.55	.	2.17E+00	.
2920	54.04	.	2.17E+00	.
3285	57.31	.	2.17E+00	.
3650	60.42	.	2.17E+00	.
4015	63.36	.	2.17E+00	.
4380	66.18	.	2.17E+00	.
4745	68.88	.	2.17E+00	.
5110	71.46	.	2.17E+00	.
5475	73.99	.	2.17E+00	.
5840	76.42	.	2.17E+00	.
6205	78.77	.	2.17E+00	.
6570	81.06	.	2.17E+00	.
6935	83.28	.	2.17E+00	.
7300	85.44	.	2.17E+00	.

Table 4-2A

Predicted and Actual Releases from TURCO 4512 using Model 2A
Corrected for radioactive decay

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 60 ml TURCO 4512 AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.18E-01	3.82E-01	-1.64E-01
2	1.41	2.83E-01	3.85E-01	-1.02E-01
3	1.73	3.35E-01	3.89E-01	-5.43E-02
4	2.00	3.72E-01	3.92E-01	-2.04E-02
7	2.65	4.45E-01	4.03E-01	4.16E-02
14	3.74	5.24E-01	4.29E-01	9.57E-02
21	4.58	5.74E-01	4.54E-01	1.20E-01
28	5.29	6.10E-01	4.79E-01	1.30E-01
80	8.94	7.05E-01	6.67E-01	3.81E-02
120	10.95	7.25E-01	8.11E-01	-8.57E-02
365	19.10	.	1.65E+00	.
730	27.02	.	2.67E+00	.
1095	33.09	.	3.31E+00	.
1460	38.21	.	3.64E+00	.
1825	42.72	.	3.77E+00	.
2190	46.80	.	3.82E+00	.
2555	50.55	.	3.83E+00	.
2920	54.04	.	3.83E+00	.
3285	57.31	.	3.83E+00	.
3650	60.42	.	3.83E+00	.
4015	63.36	.	3.83E+00	.
4380	66.18	.	3.83E+00	.
4745	68.88	.	3.83E+00	.
5110	71.48	.	3.83E+00	.
5475	73.99	.	3.83E+00	.
5840	76.42	.	3.83E+00	.
6205	78.77	.	3.83E+00	.
6570	81.06	.	3.83E+00	.
6935	83.28	.	3.83E+00	.
7300	85.44	.	3.83E+00	.

Table 5- 2A

Predicted and Actual Releases from TURCO 4512 using Model 2A
Corrected for radioactive decay

Matrix : PC-30 & BENTONITE
Waste form composition: 60 ml TURCO 4512, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	4.52E-02	1.01E-01	-5.56E-02
2	1.41	6.62E-02	1.02E-01	-3.63E-02
3	1.73	8.36E-02	1.04E-01	-2.05E-02
4	2.00	9.85E-02	1.06E-01	-7.20E-03
7	2.65	1.25E-01	1.10E-01	1.50E-02
14	3.74	1.54E-01	1.22E-01	3.19E-02
21	4.58	1.75E-01	1.33E-01	4.23E-02
28	5.29	1.92E-01	1.44E-01	4.76E-02
80	8.94	2.40E-01	2.27E-01	1.26E-02
120	10.95	2.61E-01	2.90E-01	-2.98E-02
365	19.10	.	6.61E-01	.
730	27.02	.	1.11E+00	.
1095	33.09	.	1.39E+00	.
1460	38.21	.	1.54E+00	.
1825	42.72	.	1.60E+00	.
2190	46.80	.	1.62E+00	.
2555	50.55	.	1.62E+00	.
2920	54.04	.	1.62E+00	.
3285	57.31	.	1.62E+00	.
3650	60.42	.	1.62E+00	.
4015	63.36	.	1.62E+00	.
4380	66.18	.	1.62E+00	.
4745	68.88	.	1.62E+00	.
5110	71.48	.	1.62E+00	.
5475	73.99	.	1.62E+00	.
5840	76.42	.	1.62E+00	.
6205	78.77	.	1.62E+00	.
6570	81.06	.	1.62E+00	.
6935	83.28	.	1.62E+00	.
7300	85.44	.	1.62E+00	.

Table 6-2A

Predicted and Actual Releases from TURCO 4512 using Model 2A
Corrected for radioactive decay

Matrix : PC-30 & SILICATE
Waste form composition: 60 ml TURCO 4512, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.48E-01	3.99E-01	-1.51E-01
2	1.41	3.21E-01	4.02E-01	-8.09E-02
3	1.73	3.67E-01	4.05E-01	-3.84E-02
4	2.00	4.01E-01	4.08E-01	-6.54E-03
7	2.65	4.59E-01	4.17E-01	4.18E-02
14	3.74	5.18E-01	4.38E-01	8.04E-02
21	4.58	5.54E-01	4.59E-01	9.47E-02
28	5.29	5.80E-01	4.80E-01	1.00E-01
80	8.94	6.60E-01	6.37E-01	2.34E-02
120	10.95	6.92E-01	7.56E-01	-6.38E-02
365	19.10	.	1.46E+00	.
730	27.02	.	2.30E+00	.
1095	33.09	.	2.84E+00	.
1460	38.21	.	3.11E+00	.
1825	42.72	.	3.22E+00	.
2190	46.80	.	3.26E+00	.
2555	50.55	.	3.27E+00	.
2920	54.04	.	3.27E+00	.
3285	57.31	.	3.27E+00	.
3650	60.42	.	3.27E+00	.
4015	63.36	.	3.27E+00	.
4380	66.18	.	3.27E+00	.
4745	68.88	.	3.27E+00	.
5110	71.48	.	3.27E+00	.
5475	73.99	.	3.27E+00	.
5840	76.42	.	3.27E+00	.
6205	78.77	.	3.27E+00	.
6570	81.06	.	3.27E+00	.
6935	83.28	.	3.27E+00	.
7300	85.44	.	3.27E+00	.

84-209

Table 7-2A

Predicted and Actual Releases from TURCO 4521A using Model 2A
Corrected for radioactive decay

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 40 ml TURCO 4521A AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.32E-01	2.21E-01	-8.88E-02
2	1.41	1.71E-01	2.23E-01	-5.16E-02
3	1.73	1.99E-01	2.25E-01	-2.57E-02
4	2.00	2.20E-01	2.27E-01	-6.76E-03
7	2.65	2.57E-01	2.33E-01	2.47E-02
14	3.74	2.96E-01	2.47E-01	4.95E-02
21	4.58	3.20E-01	2.61E-01	5.98E-02
28	5.29	3.38E-01	2.74E-01	6.32E-02
80	8.94	3.95E-01	3.77E-01	1.73E-02
120	10.95	4.14E-01	4.56E-01	-4.17E-02
365	19.10	.	9.16E-01	.
730	27.02	.	1.47E+00	.
1095	33.09	.	1.83E+00	.
1460	38.21	.	2.00E+00	.
1825	42.72	.	2.08E+00	.
2190	46.80	.	2.10E+00	.
2555	50.55	.	2.11E+00	.
2920	54.04	.	2.11E+00	.
3285	57.31	.	2.11E+00	.
3650	60.42	.	2.11E+00	.
4015	63.36	.	2.11E+00	.
4380	66.18	.	2.11E+00	.
4745	68.88	.	2.11E+00	.
5110	71.48	.	2.11E+00	.
5475	73.99	.	2.11E+00	.
5840	76.42	.	2.11E+00	.
6205	78.77	.	2.11E+00	.
6570	81.06	.	2.11E+00	.
6935	83.28	.	2.11E+00	.
7300	85.44	.	2.11E+00	.

Table 8-2A

Predicted and Actual Releases from TURCO 4521A using Model 2A
Corrected for radioactive decay

Matrix : PC-30 & BENTONITE
Waste form composition: 44 ml TURCO 4521A, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	3.18E-02	4.01E-02	-8.29E-03
2	1.41	3.49E-02	4.04E-02	-5.49E-03
3	1.73	3.73E-02	4.06E-02	-3.30E-03
4	2.00	3.95E-02	4.09E-02	-1.37E-03
7	2.65	4.39E-02	4.17E-02	2.21E-03
14	3.74	4.86E-02	4.37E-02	4.89E-03
21	4.58	5.21E-02	4.56E-02	6.45E-03
28	5.29	5.49E-02	4.75E-02	7.34E-03
80	8.94	6.44E-02	6.18E-02	2.51E-03
120	10.95	6.78E-02	7.28E-02	-4.94E-03
365	19.10	.	1.37E-01	.
730	27.02	.	2.14E-01	.
1095	33.09	.	2.63E-01	.
1460	38.21	.	2.88E-01	.
1825	42.72	.	2.98E-01	.
2190	46.80	.	3.02E-01	.
2555	50.55	.	3.03E-01	.
2920	54.04	.	3.03E-01	.
3285	57.31	.	3.03E-01	.
3650	60.42	.	3.03E-01	.
4015	63.36	.	3.03E-01	.
4380	66.18	.	3.03E-01	.
4745	68.88	.	3.03E-01	.
5110	71.48	.	3.03E-01	.
5475	73.99	.	3.03E-01	.
5840	76.42	.	3.03E-01	.
6205	78.77	.	3.03E-01	.
6570	81.06	.	3.03E-01	.
6935	83.28	.	3.03E-01	.
7300	85.44	.	3.03E-01	.

Table 9-2A

Predicted and Actual Releases from TURCO 4521A using Model 2A
Corrected for radioactive decay

Matrix : PC-30 & SILICATE
Waste form composition: 44 ml TURCO 4521A, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.30E-01	2.31E-01	-1.01E-01
2	1.41	1.75E-01	2.33E-01	-5.88E-02
3	1.73	2.06E-01	2.36E-01	-2.97E-02
4	2.00	2.28E-01	2.38E-01	-1.05E-02
7	2.65	2.73E-01	2.45E-01	2.75E-02
14	3.74	3.19E-01	2.62E-01	5.63E-02
21	4.58	3.48E-01	2.79E-01	6.92E-02
28	5.29	3.71E-01	2.96E-01	7.49E-02
80	8.94	4.43E-01	4.21E-01	2.14E-02
120	10.95	4.68E-01	5.17E-01	-4.93E-02
365	19.10	.	1.08E+00	.
730	27.02	.	1.75E+00	.
1095	33.09	.	2.18E+00	.
1460	38.21	.	2.40E+00	.
1825	42.72	.	2.49E+00	.
2190	46.80	.	2.52E+00	.
2555	50.55	.	2.53E+00	.
2920	54.04	.	2.53E+00	.
3285	57.31	.	2.53E+00	.
3650	60.42	.	2.53E+00	.
4015	63.36	.	2.53E+00	.
4380	66.18	.	2.53E+00	.
4745	68.88	.	2.53E+00	.
5110	71.48	.	2.53E+00	.
5475	73.99	.	2.53E+00	.
5840	76.42	.	2.53E+00	.
6205	78.77	.	2.53E+00	.
6570	81.06	.	2.53E+00	.
6935	83.28	.	2.53E+00	.
7300	85.44	.	2.53E+00	.

Table 10-2A

Predicted and Actual Releases from PEROXIDE BICARBONATE (PB) using Model 2A
Corrected for radioactive decay

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 40 ml PB AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.17E-01	2.04E-01	-8.79E-02
2	1.41	1.52E-01	2.06E-01	-5.40E-02
3	1.73	1.79E-01	2.09E-01	-2.95E-02
4	2.00	2.00E-01	2.11E-01	-1.01E-02
7	2.65	2.42E-01	2.17E-01	2.48E-02
14	3.74	2.83E-01	2.31E-01	5.24E-02
21	4.58	3.09E-01	2.45E-01	6.33E-02
28	5.29	3.26E-01	2.60E-01	6.67E-02
80	8.94	3.83E-01	3.66E-01	1.75E-02
120	10.95	4.03E-01	4.47E-01	-4.34E-02
365	19.10	.	9.21E-01	.
730	27.02	.	1.49E+00	.
1095	33.09	.	1.86E+00	.
1460	38.21	.	2.04E+00	.
1825	42.72	.	2.12E+00	.
2190	46.80	.	2.14E+00	.
2555	50.55	.	2.15E+00	.
2920	54.04	.	2.15E+00	.
3285	57.31	.	2.15E+00	.
3650	60.42	.	2.15E+00	.
4015	63.36	.	2.15E+00	.
4380	66.18	.	2.15E+00	.
4745	68.88	.	2.15E+00	.
5110	71.48	.	2.15E+00	.
5475	73.99	.	2.15E+00	.
5840	76.42	.	2.15E+00	.
6205	78.77	.	2.15E+00	.
6570	81.06	.	2.15E+00	.
6935	83.28	.	2.15E+00	.
7300	85.44	.	2.15E+00	.

84-209

Table 11-2A

Predicted and Actual Releases from PEROXIDE BICARBONATE (PB) using Model 2A
Corrected for radioactive decay

Matrix : PC-30 & BENTONITE
Waste form composition: 44 ml PB, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	4.06E-03	9.31E-03	-5.25E-03
2	1.41	5.99E-03	9.47E-03	-3.48E-03
3	1.73	7.62E-03	9.63E-03	-2.02E-03
4	2.00	8.99E-03	9.79E-03	-8.05E-04
7	2.65	1.18E-02	1.03E-02	1.51E-03
14	3.74	1.46E-02	1.14E-02	3.17E-03
21	4.58	1.65E-02	1.25E-02	3.98E-03
28	5.29	1.81E-02	1.37E-02	4.48E-03
80	8.94	2.33E-02	2.20E-02	1.33E-03
120	10.95	2.54E-02	2.84E-02	-2.91E-03
365	19.10	.	6.56E-02	.
730	27.02	.	1.11E-01	.
1095	33.09	.	1.39E-01	.
1460	38.21	.	1.54E-01	.
1825	42.72	.	1.60E-01	.
2190	46.80	.	1.62E-01	.
2555	50.55	.	1.62E-01	.
2920	54.04	.	1.62E-01	.
3285	57.31	.	1.62E-01	.
3650	60.42	.	1.62E-01	.
4015	63.36	.	1.62E-01	.
4380	66.18	.	1.62E-01	.
4745	68.88	.	1.62E-01	.
5110	71.48	.	1.62E-01	.
5475	73.99	.	1.62E-01	.
5840	76.42	.	1.62E-01	.
6205	78.77	.	1.62E-01	.
6570	81.06	.	1.62E-01	.
6935	83.28	.	1.62E-01	.
7300	85.44	.	1.62E-01	.

Table 12-2A

Predicted and Actual Releases from PEROXIDE BICARBONATE (PB) using Model 2A
Corrected for radioactive decay

Matrix : PC-30 & SILICATE
Waste form composition: 44 ml PB, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.38E-01	2.45E-01	-1.06E-01
2	1.41	1.86E-01	2.47E-01	-6.17E-02
3	1.73	2.18E-01	2.50E-01	-3.17E-02
4	2.00	2.43E-01	2.52E-01	-8.98E-03
7	2.65	2.90E-01	2.59E-01	3.06E-02
14	3.74	3.35E-01	2.76E-01	5.96E-02
21	4.58	3.64E-01	2.92E-01	7.16E-02
28	5.29	3.86E-01	3.09E-01	7.69E-02
80	8.94	4.52E-01	4.32E-01	1.97E-02
120	10.95	4.77E-01	5.27E-01	-4.95E-02
365	19.10	.	1.08E+00	.
730	27.02	.	1.74E+00	.
1095	33.09	.	2.17E+00	.
1460	38.21	.	2.38E+00	.
1825	42.72	.	2.47E+00	.
2190	46.80	.	2.50E+00	.
2555	50.55	.	2.51E+00	.
2920	54.04	.	2.51E+00	.
3285	57.31	.	2.51E+00	.
3650	60.42	.	2.51E+00	.
4015	63.36	.	2.51E+00	.
4380	66.18	.	2.51E+00	.
4745	68.88	.	2.51E+00	.
5110	71.48	.	2.51E+00	.
5475	73.99	.	2.51E+00	.
5840	76.42	.	2.51E+00	.
6205	78.77	.	2.51E+00	.
6570	81.06	.	2.51E+00	.
6935	83.28	.	2.51E+00	.
7300	85.44	.	2.51E+00	.

Table 13-2A

Predicted and Actual Releases from POTASSIUM PERSULFATE (PP) using Model 2A
Corrected for radioactive decay

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 70 ml PP AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.06E-01	3.72E-01	-1.66E-01
2	1.41	2.78E-01	3.75E-01	-9.73E-02
3	1.73	3.29E-01	3.79E-01	-4.99E-02
4	2.00	3.69E-01	3.82E-01	-1.34E-02
7	2.65	4.38E-01	3.92E-01	4.56E-02
14	3.74	5.10E-01	4.17E-01	9.30E-02
21	4.58	5.55E-01	4.41E-01	1.14E-01
28	5.29	5.87E-01	4.65E-01	1.21E-01
80	8.94	6.76E-01	6.45E-01	3.04E-02
120	10.95	7.05E-01	7.83E-01	-7.76E-02
365	19.10	.	1.59E+00	.
730	27.02	.	2.56E+00	.
1095	33.09	.	3.18E+00	.
1460	38.21	.	3.49E+00	.
1825	42.72	.	3.62E+00	.
2190	46.80	.	3.66E+00	.
2555	50.55	.	3.67E+00	.
2920	54.04	.	3.67E+00	.
3285	57.31	.	3.67E+00	.
3650	60.42	.	3.67E+00	.
4015	63.36	.	3.67E+00	.
4380	66.18	.	3.67E+00	.
4745	68.88	.	3.67E+00	.
5110	71.48	.	3.67E+00	.
5475	73.99	.	3.67E+00	.
5840	76.42	.	3.67E+00	.
6205	78.77	.	3.67E+00	.
6570	81.06	.	3.67E+00	.
6935	83.28	.	3.67E+00	.
7300	85.44	.	3.67E+00	.

Table 14-2A
Predicted and Actual Releases from POTASSIUM PERSULFATE (PP) using Model 2A
Corrected for radioactive decay

Matrix : PC-30 & BENTONITE
Waste form composition: 70 ml PP, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	3.88E-02	7.20E-02	-3.32E-02
2	1.41	4.86E-02	7.29E-02	-2.44E-02
3	1.73	6.01E-02	7.38E-02	-1.38E-02
4	2.00	6.98E-02	7.48E-02	-4.98E-03
7	2.65	8.74E-02	7.75E-02	9.85E-03
14	3.74	1.05E-01	8.40E-02	2.10E-02
21	4.58	1.17E-01	9.05E-02	2.67E-02
28	5.29	1.27E-01	9.69E-02	2.98E-02
80	8.94	1.52E-01	1.45E-01	7.51E-03
120	10.95	1.63E-01	1.81E-01	-1.85E-02
365	19.10	.	3.95E-01	.
730	27.02	.	6.54E-01	.
1095	33.09	.	8.19E-01	.
1460	38.21	.	9.02E-01	.
1825	42.72	.	9.36E-01	.
2190	46.80	.	9.47E-01	.
2555	50.55	.	9.49E-01	.
2920	54.04	.	9.50E-01	.
3285	57.31	.	9.50E-01	.
3650	60.42	.	9.50E-01	.
4015	63.36	.	9.50E-01	.
4380	66.18	.	9.50E-01	.
4745	68.88	.	9.50E-01	.
5110	71.48	.	9.50E-01	.
5475	73.99	.	9.50E-01	.
5840	76.42	.	9.50E-01	.
6205	78.77	.	9.50E-01	.
6570	81.06	.	9.50E-01	.
6935	83.28	.	9.50E-01	.
7300	85.44	.	9.50E-01	.

Table 15-2A

Predicted and Actual Releases from POTASSIUM PERSULFATE (PP) using Model 2A
Corrected for radioactive decay

Matrix : PC-30 & SILICATE
Waste form composition: 70 ml PP, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.08E-01	3.66E-01	-1.59E-01
2	1.41	2.79E-01	3.70E-01	-9.13E-02
3	1.73	3.28E-01	3.74E-01	-4.56E-02
4	2.00	3.66E-01	3.78E-01	-1.15E-02
7	2.65	4.29E-01	3.89E-01	4.00E-02
14	3.74	5.04E-01	4.15E-01	8.87E-02
21	4.58	5.51E-01	4.42E-01	1.09E-01
28	5.29	5.84E-01	4.68E-01	1.16E-01
80	8.94	6.89E-01	6.63E-01	2.59E-02
120	10.95	7.41E-01	8.13E-01	-7.19E-02
365	19.10	.	1.69E+00	.
730	27.02	.	2.74E+00	.
1095	33.09	.	3.41E+00	.
1460	38.21	.	3.76E+00	.
1825	42.72	.	3.89E+00	.
2190	46.80	.	3.94E+00	.
2555	50.55	.	3.95E+00	.
2920	54.04	.	3.95E+00	.
3285	57.31	.	3.95E+00	.
3650	60.42	.	3.95E+00	.
4015	63.36	.	3.95E+00	.
4380	66.18	.	3.95E+00	.
4745	68.88	.	3.95E+00	.
5110	71.48	.	3.95E+00	.
5475	73.99	.	3.95E+00	.
5840	76.42	.	3.95E+00	.
6205	78.77	.	3.95E+00	.
6570	81.06	.	3.95E+00	.
6935	83.28	.	3.95E+00	.
7300	85.44	.	3.95E+00	.

APPENDIX 8

FIGURE 1-2

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 2

WASTE=ALKALINE PERMANGANATE (AP)

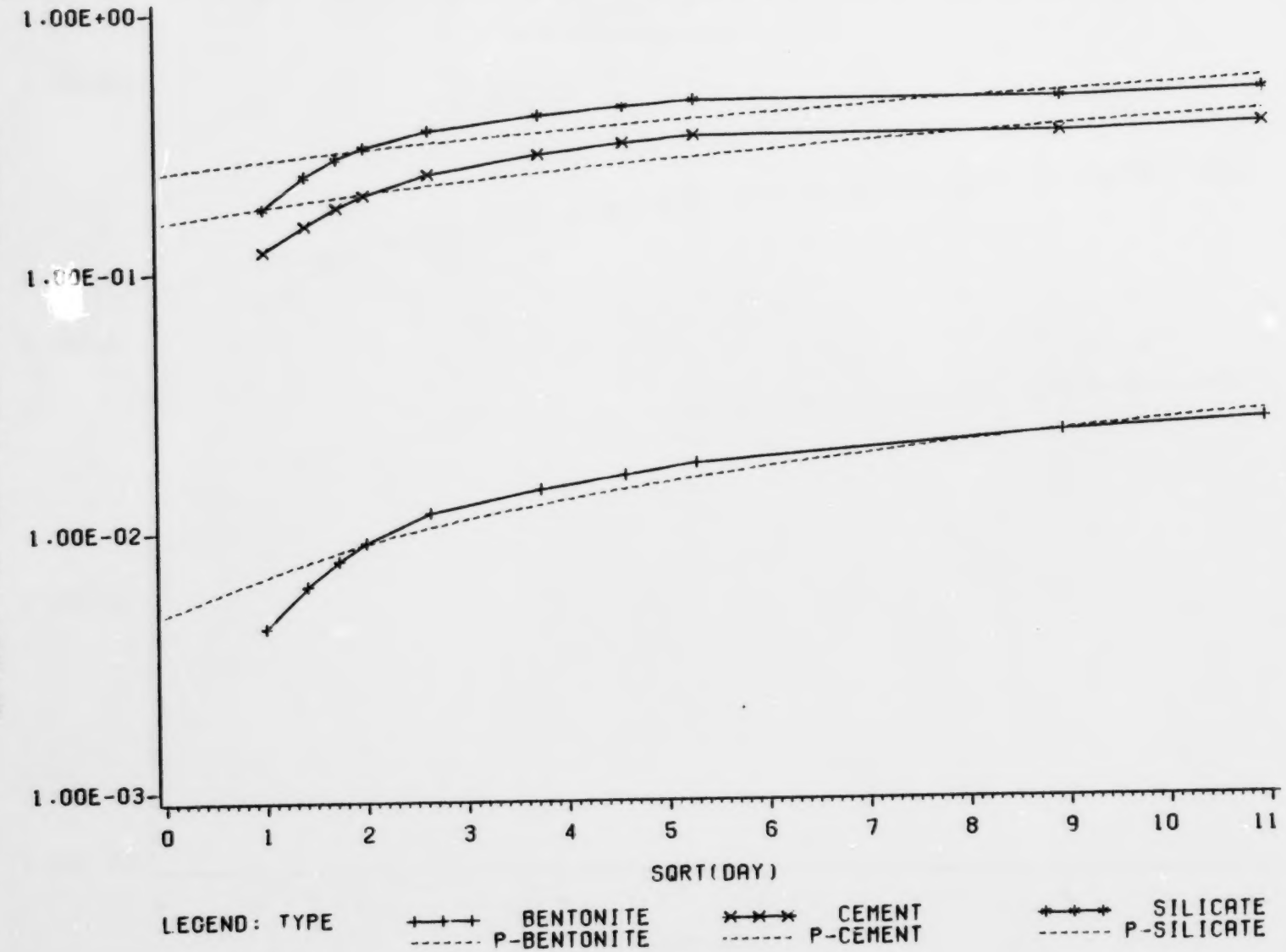


FIGURE 2-2

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 2
WASTE=TURCO 4512

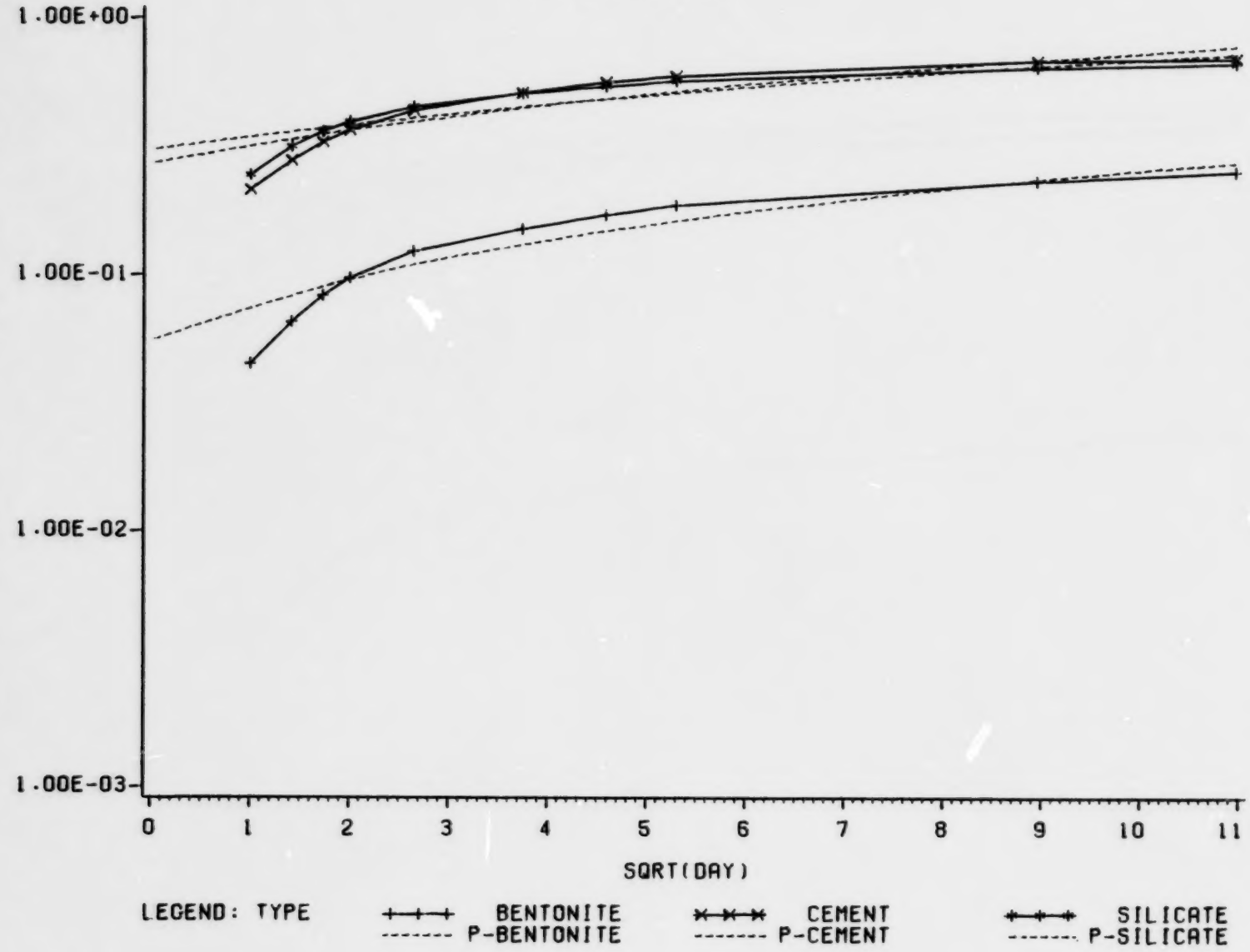


FIGURE 3-2

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 2
WASTE=TURCO 4521A

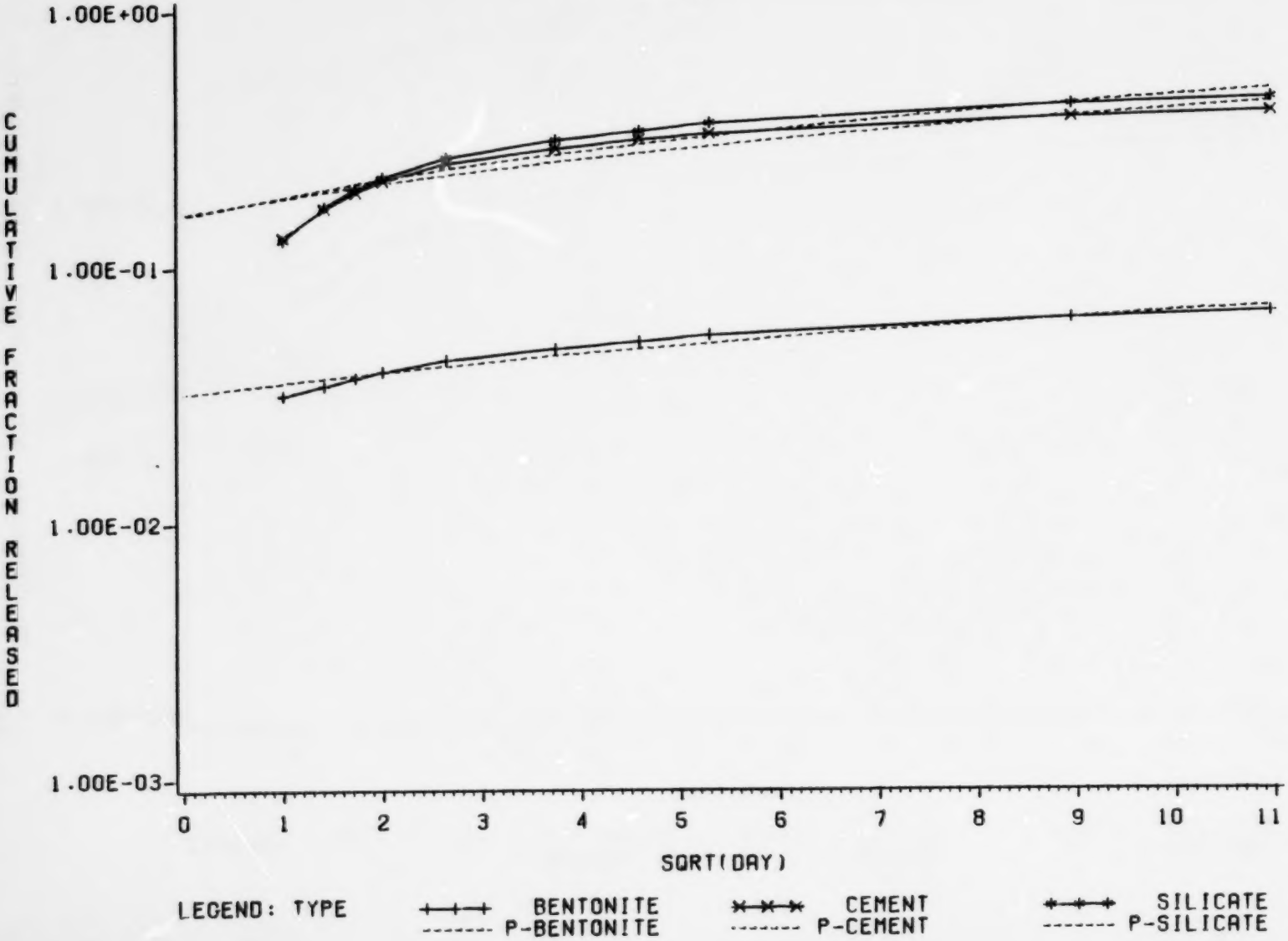


FIGURE 4-2

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 2

WASTE=PEROXIDE BICARBONATE (PB)

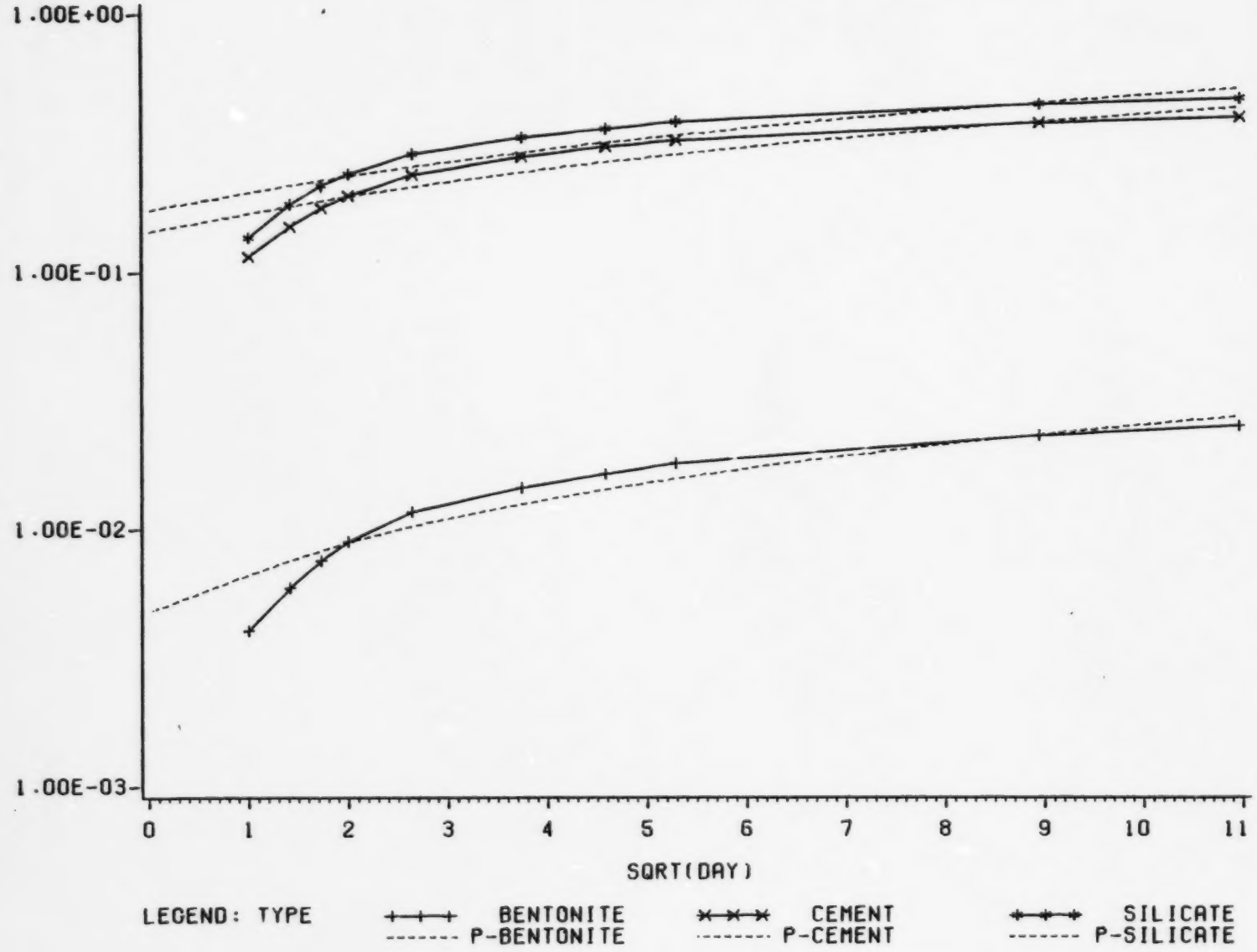
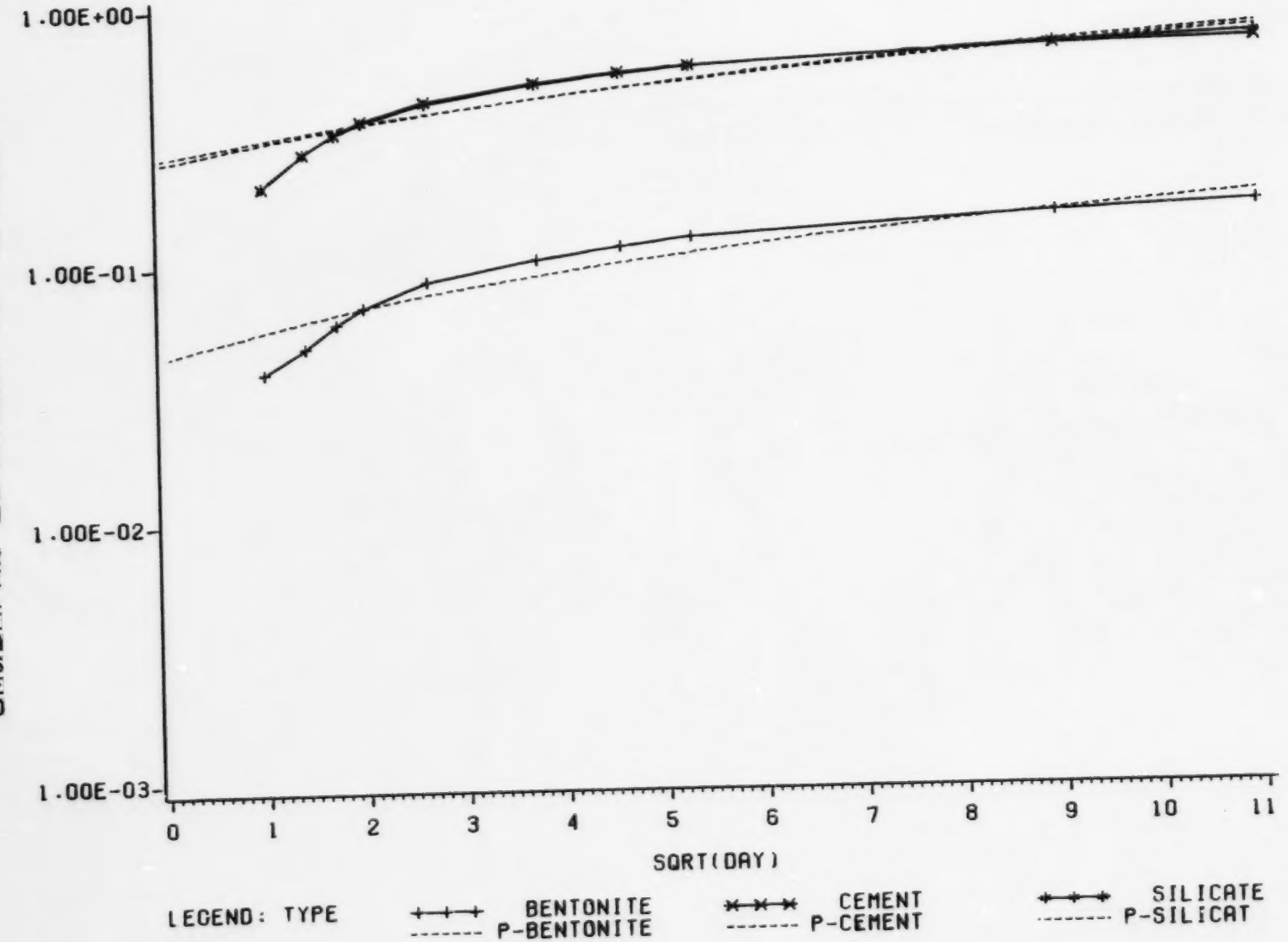


FIGURE 5-2

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 2

WASTE=POTASSIUM PERSULFATE (PP)



84-209

APPENDIX 9

FIGURE 1-2A

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 2A ADJUSTED FOR RADIOACTIVE DECAY
WASTE=ALKALINE PERMANGANATE (AP)

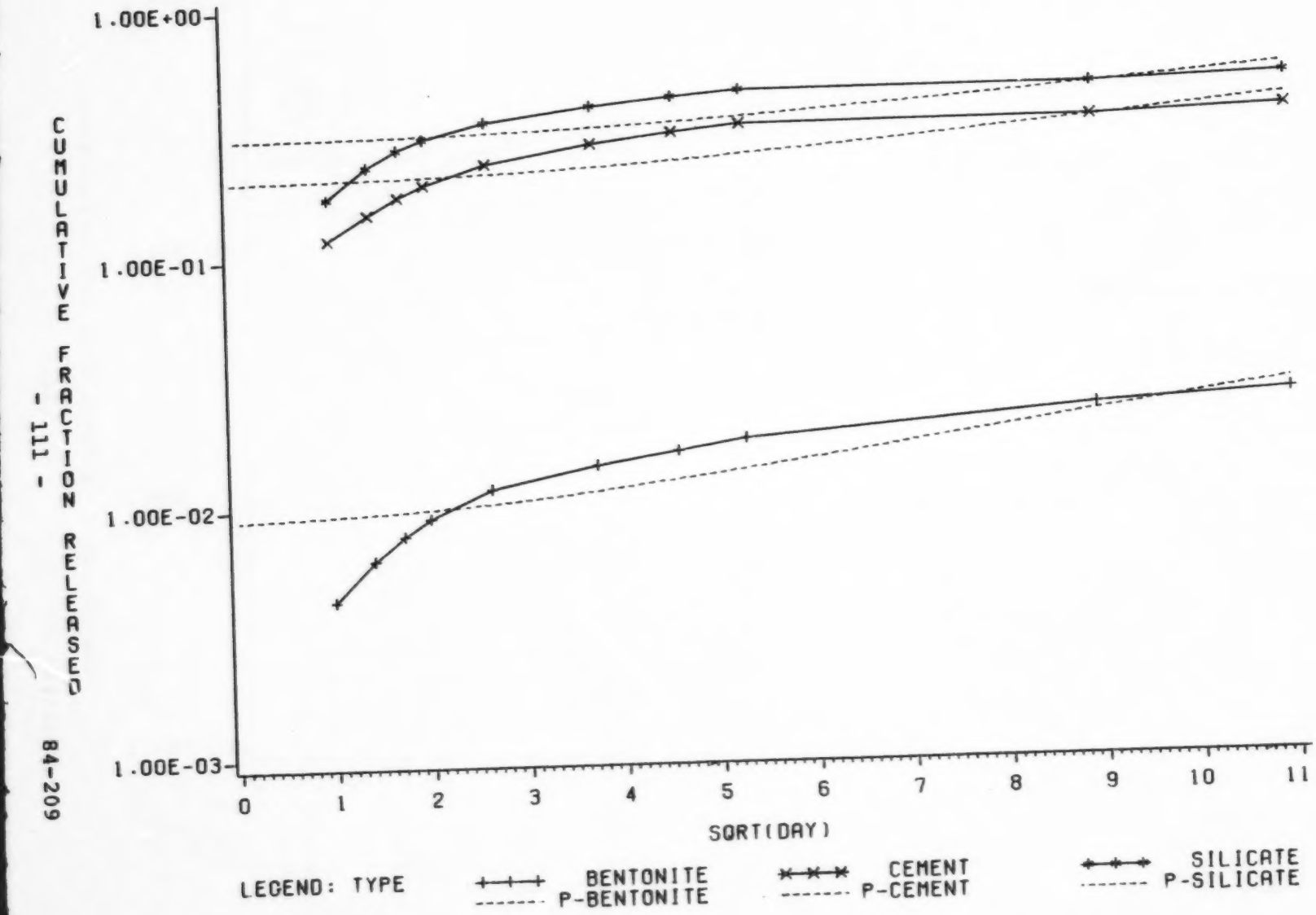


FIGURE 2-2A

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 2A ADJUSTED FOR RADIOACTIVE DECAY
WASTE=TURCO 4512

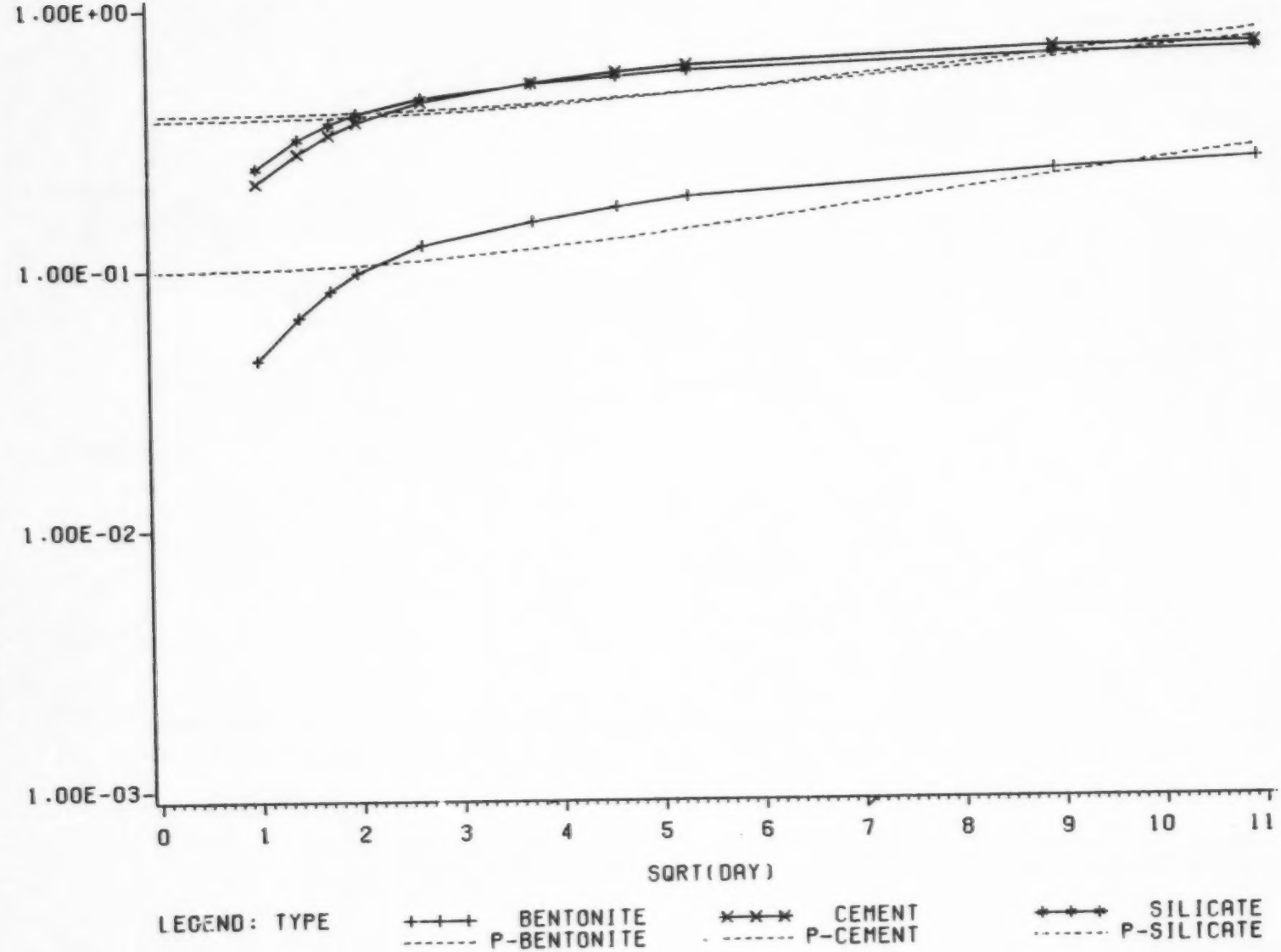


FIGURE 3-2A

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL2A ADJUSTED FOR RADIOACTIVE DECAY
WASTE=TURCO 4521A

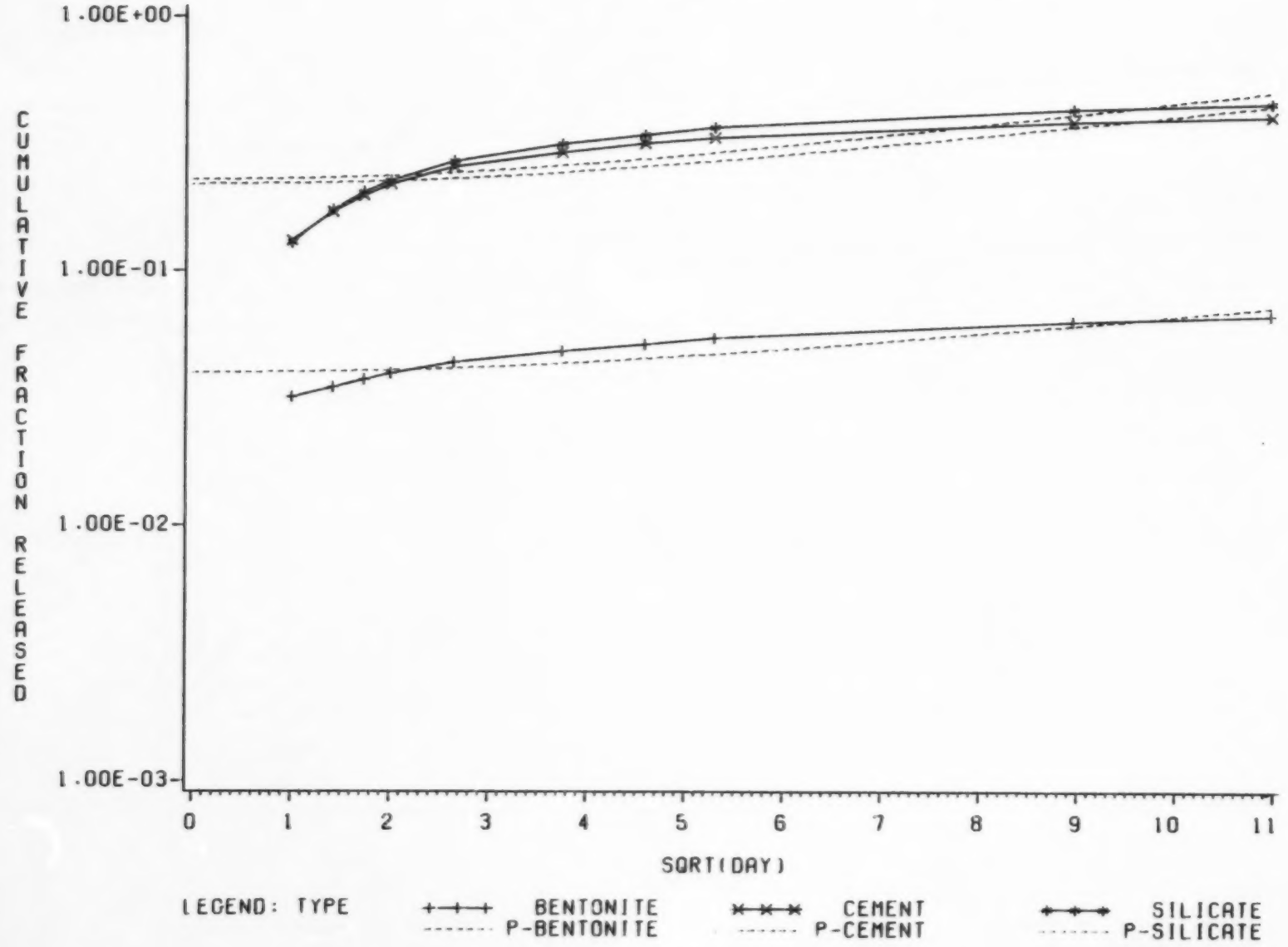
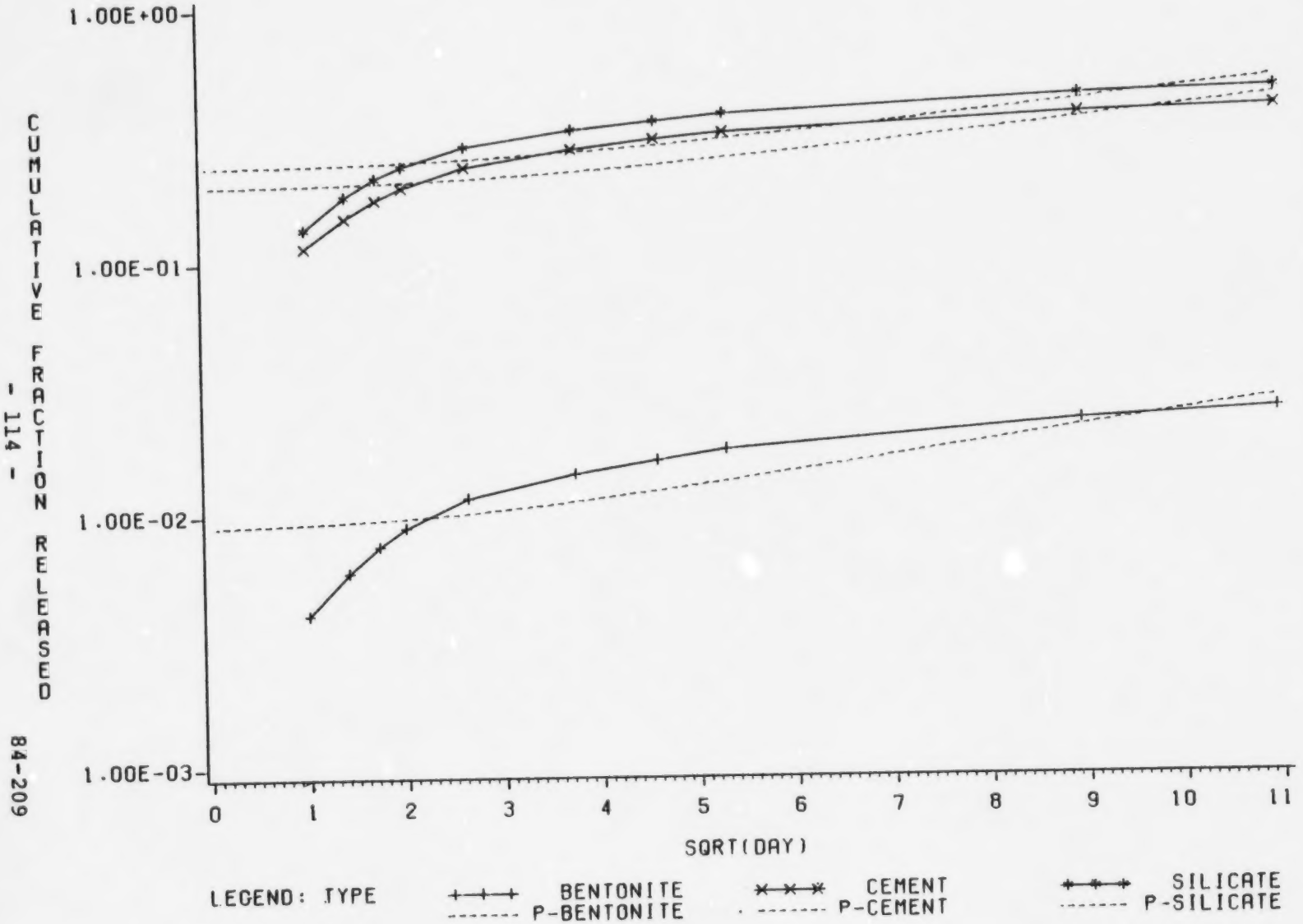


FIGURE 4-2A

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 2A ADJUSTED FOR RADIOACTIVE DECAY
WASTE=PEROXIDE BICARBONATE (PB)

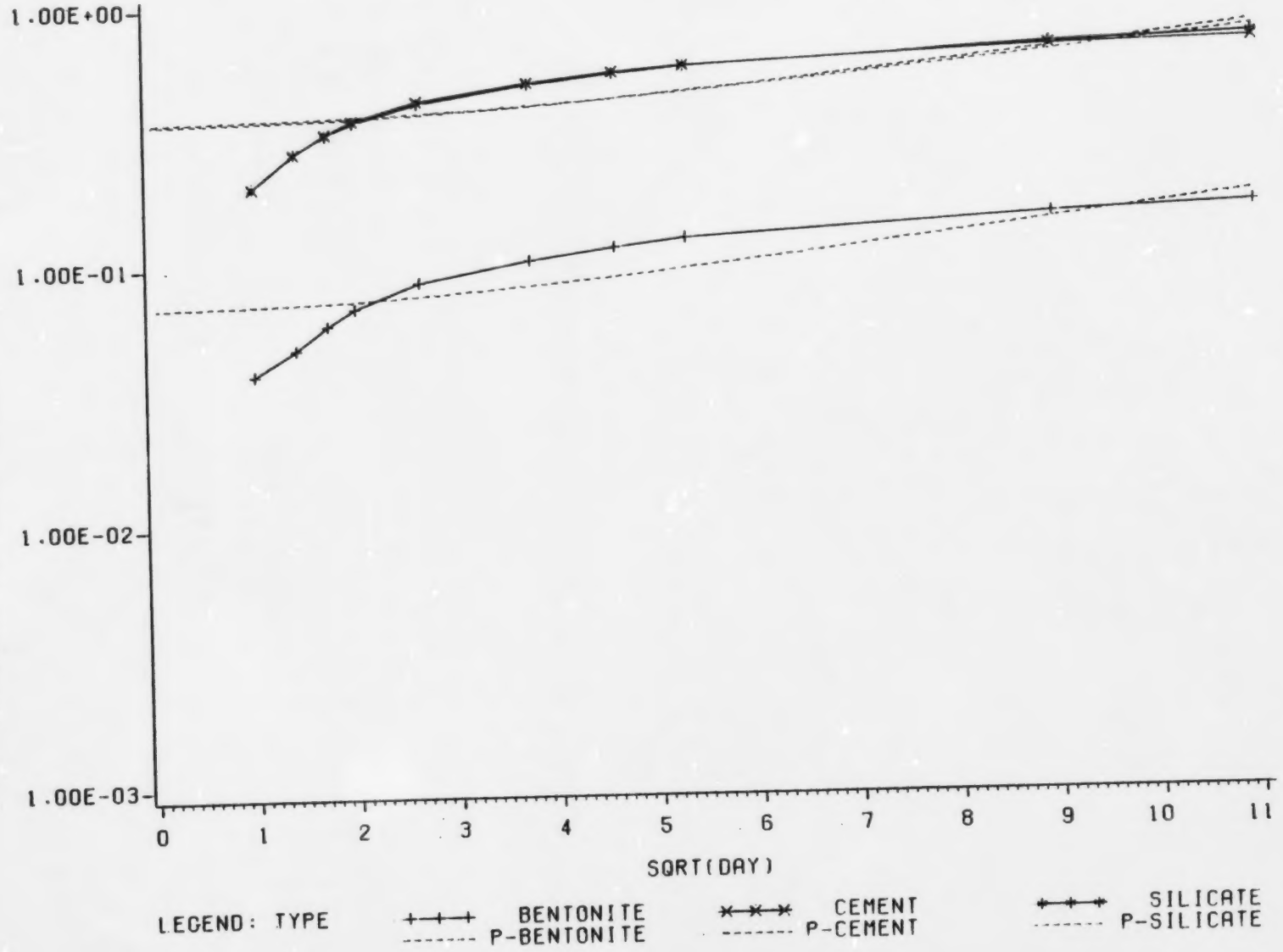


84-209

FIGURE 5-2A

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 2A ADJUSTED FOR RADIOACTIVE DECAY
WASTE=POTASSIUM PERSULFATE (PP)



84-209

APPENDIX 10

Table 1-3

Predicted and Actual Releases from ALKALINE PERMANGANATE (AP) using Model 3

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 40 ml AP AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.21E-01	1.21E-01	2.24E-04
2	1.41	1.53E-01	1.54E-01	-3.51E-04
3	1.73	1.79E-01	1.79E-01	-6.84E-05
4	2.00	2.00E-01	2.00E-01	1.96E-04
7	2.65	2.42E-01	2.74E-01	-3.19E-02
14	3.74	2.86E-01	2.87E-01	-8.70E-04
21	4.58	3.15E-01	2.97E-01	1.74E-02
28	5.29	3.36E-01	3.06E-01	3.07E-02
80	8.94	3.43E-01	3.50E-01	-6.65E-03
120	10.95	3.66E-01	3.75E-01	-8.66E-03
365	19.10	.	4.73E-01	.
730	27.02	.	5.69E-01	.
1095	33.09	.	6.43E-01	.
1460	38.21	.	7.05E-01	.
1825	42.72	.	7.60E-01	.
2190	46.80	.	8.09E-01	.
2555	50.55	.	8.55E-01	.
2920	54.04	.	8.97E-01	.
3285	57.31	.	9.37E-01	.
3650	60.42	.	9.75E-01	.
4015	63.36	.	1.01E+00	.
4380	66.18	.	1.04E+00	.
4745	68.88	.	1.08E+00	.
5110	71.48	.	1.11E+00	.
5475	73.99	.	1.14E+00	.
5840	76.42	.	1.17E+00	.
6205	78.77	.	1.20E+00	.
6570	81.06	.	1.23E+00	.
6935	83.28	.	1.25E+00	.
7300	85.44	.	1.28E+00	.

Data are not corrected for radioactive decay

Table 2-3

Predicted and Actual Releases from ALKALINE PERMANGANATE (AP) using Model 3

Matrix : PC-30 & BENTONITE
Waste form composition: 44 ml AP, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	4.30E-03	4.26E-03	3.24E-05
2	1.41	6.21E-03	6.26E-03	-4.54E-05
3	1.73	7.77E-03	7.79E-03	-2.18E-05
4	2.00	9.11E-03	9.08E-03	3.48E-05
7	2.65	1.18E-02	1.28E-02	-9.97E-04
14	3.74	1.45E-02	1.46E-02	-7.23E-05
21	4.58	1.65E-02	1.60E-02	4.47E-04
28	5.29	1.81E-02	1.72E-02	9.27E-04
80	8.94	2.36E-02	2.33E-02	3.51E-04
120	10.95	2.59E-02	2.66E-02	-6.56E-04
365	19.10	.	4.01E-02	.
730	27.02	.	5.33E-02	.
1095	33.09	.	6.33E-02	.
1460	38.21	.	7.18E-02	.
1825	42.72	.	7.93E-02	.
2190	46.80	.	8.61E-02	.
2555	50.55	.	9.23E-02	.
2920	54.04	.	9.81E-02	.
3285	57.31	.	1.04E-01	.
3650	60.42	.	1.09E-01	.
4015	63.36	.	1.14E-01	.
4380	66.18	.	1.18E-01	.
4745	68.88	.	1.23E-01	.
5110	71.48	.	1.27E-01	.
5475	73.99	.	1.31E-01	.
5840	76.42	.	1.35E-01	.
6205	78.77	.	1.39E-01	.
6570	81.06	.	1.43E-01	.
6935	83.28	.	1.47E-01	.
7300	85.44	.	1.50E-01	.

Data are not corrected for radioactive decay

Table 3-3

Predicted and Actual Releases from ALKALINE PERMANGANATE (AP) using Model 3

Matrix : PC-30 & SILICATE

Waste form composition: 44 ml AP, 100 g PORTLAND TYPE 30 CEMENT, AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.78E-01	1.81E-01	-2.98E-03
2	1.41	2.38E-01	2.34E-01	3.99E-03
3	1.73	2.77E-01	2.74E-01	2.41E-03
4	2.00	3.05E-01	3.09E-01	-3.42E-03
7	2.65	3.55E-01	3.90E-01	-3.53E-02
14	3.74	4.05E-01	4.05E-01	-2.60E-04
21	4.58	4.36E-01	4.16E-01	1.99E-02
28	5.29	4.59E-01	4.26E-01	3.29E-02
80	8.94	4.65E-01	4.74E-01	-8.92E-03
120	10.95	4.93E-01	5.01E-01	-8.32E-03
365	19.10	.	6.10E-01	.
730	27.02	.	7.15E-01	.
1095	33.09	.	7.96E-01	.
1460	38.21	.	8.64E-01	.
1825	42.72	.	9.24E-01	.
2190	46.80	.	9.79E-01	.
2555	50.55	.	1.03E+00	.
2920	54.04	.	1.08E+00	.
3285	57.31	.	1.12E+00	.
3650	60.42	.	1.16E+00	.
4015	63.36	.	1.20E+00	.
4380	66.18	.	1.24E+00	.
4745	68.88	.	1.27E+00	.
5110	71.48	.	1.31E+00	.
5475	73.99	.	1.34E+00	.
5840	76.42	.	1.37E+00	.
6205	78.77	.	1.40E+00	.
6570	81.06	.	1.44E+00	.
6935	83.28	.	1.46E+00	.
7300	85.44	.	1.49E+00	.

Data are not corrected for radioactive decay

Table 4-3

Predicted and Actual Releases from TURCO 4512 using Model 3

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 60 ml TURCO 4512 AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.18E-01	2.18E-01	-9.10E-04
2	1.41	2.83E-01	2.83E-01	5.24E-04
3	1.73	3.35E-01	3.32E-01	2.25E-03
4	2.00	3.72E-01	3.74E-01	-1.87E-03
7	2.65	4.45E-01	4.90E-01	-4.51E-02
14	3.74	5.24E-01	5.25E-01	-5.12E-04
21	4.58	5.74E-01	5.52E-01	2.28E-02
28	5.29	6.10E-01	5.74E-01	3.57E-02
60	8.94	7.05E-01	6.90E-01	1.55E-02
120	10.95	7.25E-01	7.54E-01	-2.84E-02
365	19.10	.	1.01E+00	.
730	27.02	.	1.26E+00	.
1095	33.09	.	1.46E+00	.
1460	38.21	.	1.62E+00	.
1825	42.72	.	1.76E+00	.
2190	46.80	.	1.89E+00	.
2555	50.55	.	2.01E+00	.
2920	54.04	.	2.12E+00	.
3285	57.31	.	2.23E+00	.
3650	60.42	.	2.32E+00	.
4015	63.36	.	2.42E+00	.
4380	66.18	.	2.51E+00	.
4745	68.88	.	2.59E+00	.
5110	71.48	.	2.68E+00	.
5475	73.99	.	2.75E+00	.
5840	76.42	.	2.83E+00	.
6205	78.77	.	2.91E+00	.
6570	81.06	.	2.98E+00	.
6935	83.28	.	3.05E+00	.
7300	85.44	.	3.12E+00	.

Data are not corrected for radioactive decay

Table 5-3

Predicted and Actual Releases from TURCO 4512 using Model 3

Matrix : PC-30 & BENTONITE
Waste form composition: 60 ml TURCO 4512, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	4.52E-02	4.48E-02	4.39E-04
2	1.41	6.62E-02	6.69E-02	-6.56E-04
3	1.73	8.36E-02	8.38E-02	-2.04E-04
4	2.00	9.85E-02	9.81E-02	4.21E-04
7	2.65	1.25E-01	1.38E-01	-1.27E-02
14	3.74	1.54E-01	1.55E-01	-1.68E-03
21	4.58	1.75E-01	1.68E-01	6.69E-03
28	5.29	1.92E-01	1.80E-01	1.22E-02
80	8.94	2.40E-01	2.37E-01	2.99E-03
120	10.95	2.61E-01	2.68E-01	-7.48E-03
365	19.10	.	3.96E-01	.
730	27.02	.	5.19E-01	.
1095	33.09	.	6.14E-01	.
1460	38.21	.	6.94E-01	.
1825	42.72	.	7.65E-01	.
2190	46.80	.	8.29E-01	.
2555	50.55	.	8.87E-01	.
2920	54.04	.	9.42E-01	.
3285	57.31	.	9.93E-01	.
3650	60.42	.	1.04E+00	.
4015	63.36	.	1.09E+00	.
4380	66.18	.	1.13E+00	.
4745	68.88	.	1.17E+00	.
5110	71.48	.	1.21E+00	.
5475	73.99	.	1.25E+00	.
5840	76.42	.	1.29E+00	.
6205	78.77	.	1.33E+00	.
6570	81.06	.	1.36E+00	.
6935	83.28	.	1.40E+00	.
7300	85.44	.	1.43E+00	.

Data are not corrected for radioactive decay

Table 6-3

Predicted and Actual Releases from TURCO 4512 using Model 3

Matrix : PC-30 & SILICATE

Waste form composition: 60 ml TURCO 4512, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.48E-01	2.52E-01	-3.80E-03
2	1.41	3.21E-01	3.16E-01	5.45E-03
3	1.73	3.67E-01	3.64E-01	2.26E-03
4	2.00	4.01E-01	4.05E-01	-3.91E-03
7	2.65	4.59E-01	4.88E-01	-2.93E-02
14	3.74	5.18E-01	5.17E-01	1.51E-03
21	4.58	5.54E-01	5.39E-01	1.48E-02
28	5.29	5.80E-01	5.58E-01	2.24E-02
80	8.94	6.60E-01	6.54E-01	5.69E-03
120	10.95	6.92E-01	7.07E-01	-1.51E-02
365	19.10	.	9.23E-01	.
730	27.02	.	1.13E+00	.
1095	33.09	.	1.29E+00	.
1460	38.21	.	1.43E+00	.
1825	42.72	.	1.55E+00	.
2190	46.80	.	1.65E+00	.
2555	50.55	.	1.75E+00	.
2920	54.04	.	1.85E+00	.
3285	57.31	.	1.93E+00	.
3650	60.42	.	2.01E+00	.
4015	63.36	.	2.09E+00	.
4380	66.18	.	2.17E+00	.
4745	68.88	.	2.24E+00	.
5110	71.48	.	2.31E+00	.
5475	73.99	.	2.37E+00	.
5840	76.42	.	2.44E+00	.
6205	78.77	.	2.50E+00	.
6570	81.06	.	2.56E+00	.
6935	83.28	.	2.62E+00	.
7300	85.44	.	2.67E+00	.

Data are not corrected for radioactive decay

Table 7-3

Predicted and Actual Releases from TURCO 4521A using Model 3

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 40 ml TURCO 4521A AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.32E-01	1.33E-01	-1.18E-03
2	1.41	1.71E-01	1.70E-01	1.46E-03
3	1.73	1.99E-01	1.98E-01	1.20E-03
4	2.00	2.20E-01	2.22E-01	-1.48E-03
7	2.65	2.57E-01	2.76E-01	-1.86E-02
14	3.74	2.96E-01	2.96E-01	4.47E-04
21	4.58	3.20E-01	3.11E-01	9.51E-03
28	5.29	3.38E-01	3.24E-01	1.41E-02
80	8.94	3.95E-01	3.89E-01	5.50E-03
120	10.95	4.14E-01	4.25E-01	-1.09E-02
365	19.10	.	5.72E-01	.
730	27.02	.	7.14E-01	.
1095	33.09	.	8.23E-01	.
1460	38.21	.	9.14E-01	.
1825	42.72	.	9.95E-01	.
2190	46.80	.	1.07E+00	.
2555	50.55	.	1.14E+00	.
2920	54.04	.	1.20E+00	.
3285	57.31	.	1.26E+00	.
3650	60.42	.	1.31E+00	.
4015	63.36	.	1.37E+00	.
4380	66.18	.	1.42E+00	.
4745	68.88	.	1.46E+00	.
5110	71.48	.	1.51E+00	.
5475	73.99	.	1.56E+00	.
5840	76.42	.	1.60E+00	.
6205	78.77	.	1.64E+00	.
6570	81.06	.	1.68E+00	.
6935	83.28	.	1.72E+00	.
7300	85.44	.	1.76E+00	.

Data are not corrected for radioactive decay

Table 8-3

Predicted and Actual Releases from TURCO 4521A using Model 3

Matrix : PC-30 & BENTONITE

Waste form composition: 44 ml TURCO 4521A, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	3.18E-02	3.17E-02	5.61E-05
2	1.41	3.49E-02	3.49E-02	-6.75E-05
3	1.73	3.73E-02	3.74E-02	-6.17E-05
4	2.00	3.95E-02	3.95E-02	7.31E-05
7	2.65	4.39E-02	4.57E-02	-1.78E-03
14	3.74	4.86E-02	4.88E-02	-2.57E-04
21	4.58	5.21E-02	5.12E-02	8.55E-04
28	5.29	5.49E-02	5.32E-02	1.67E-03
80	8.94	6.44E-02	6.35E-02	8.48E-04
120	10.95	6.78E-02	6.92E-02	-1.34E-03
365	19.10	.	9.22E-02	.
730	27.02	.	1.15E-01	.
1095	33.09	.	1.32E-01	.
1460	38.21	.	1.46E-01	.
1825	42.72	.	1.59E-01	.
2190	46.80	.	1.70E-01	.
2555	50.55	.	1.81E-01	.
2920	54.04	.	1.91E-01	.
3285	57.31	.	2.00E-01	.
3650	60.42	.	2.09E-01	.
4015	63.36	.	2.17E-01	.
4380	66.18	.	2.25E-01	.
4745	68.88	.	2.33E-01	.
5110	71.48	.	2.40E-01	.
5475	73.99	.	2.47E-01	.
5840	76.42	.	2.54E-01	.
6205	78.77	.	2.61E-01	.
6570	81.06	.	2.67E-01	.
6935	83.28	.	2.73E-01	.
7300	85.44	.	2.80E-01	.

Data are not corrected for radioactive decay

Table 9-3

Predicted and Actual Releases from TURCO 4521A using Model 3

Matrix : PC-30 & SILICATE
Waste form composition: 44 ml TURCO 4521A, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.30E-01	1.32E-01	-1.82E-03
2	1.41	1.75E-01	1.72E-01	2.08E-03
3	1.73	2.06E-01	2.04E-01	2.25E-03
4	2.00	2.28E-01	2.30E-01	-2.51E-03
7	2.65	2.73E-01	2.94E-01	-2.14E-02
14	3.74	3.19E-01	3.19E-01	-2.96E-04
21	4.58	3.48E-01	3.38E-01	1.06E-02
28	5.29	3.71E-01	3.54E-01	1.73E-02
60	8.94	4.43E-01	4.36E-01	6.91E-03
120	10.95	4.68E-01	4.81E-01	-1.32E-02
365	19.10	.	6.64E-01	.
730	27.02	.	8.42E-01	.
1095	33.09	.	9.78E-01	.
1460	38.21	.	1.09E+00	.
1825	42.72	.	1.19E+00	.
2190	46.80	.	1.29E+00	.
2555	50.55	.	1.37E+00	.
2920	54.04	.	1.45E+00	.
3285	57.31	.	1.52E+00	.
3650	60.42	.	1.59E+00	.
4015	63.36	.	1.66E+00	.
4380	66.18	.	1.72E+00	.
4745	68.88	.	1.78E+00	.
5110	71.48	.	1.84E+00	.
5475	73.99	.	1.90E+00	.
5840	76.42	.	1.95E+00	.
6205	78.77	.	2.00E+00	.
6570	81.06	.	2.06E+00	.
6935	83.28	.	2.10E+00	.
7300	85.44	.	2.15E+00	.

Data are not corrected for radioactive decay

Table 10-3

Predicted and Actual Releases from PEROXIDE BICARBONATE (PB) using Model 3

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 40 ml PB AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.17E-01	1.17E-01	-4.83E-04
2	1.41	1.52E-01	1.52E-01	6.08E-04
3	1.73	1.79E-01	1.79E-01	4.73E-04
4	2.00	2.00E-01	2.01E-01	-5.98E-04
7	2.65	2.42E-01	2.62E-01	-2.09E-02
14	3.74	2.83E-01	2.82E-01	9.86E-04
21	4.58	3.09E-01	2.98E-01	1.07E-02
28	5.29	3.26E-01	3.11E-01	1.54E-02
80	8.94	3.83E-01	3.78E-01	5.22E-03
120	10.95	4.03E-01	4.15E-01	-1.15E-02
365	19.10	.	5.65E-01	.
730	27.02	.	7.10E-01	.
1095	33.09	.	8.21E-01	.
1460	38.21	.	9.15E-01	.
1825	42.72	.	9.98E-01	.
2190	46.80	.	1.07E+00	.
2555	50.55	.	1.14E+00	.
2920	54.04	.	1.21E+00	.
3285	57.31	.	1.27E+00	.
3650	60.42	.	1.32E+00	.
4015	63.36	.	1.38E+00	.
4380	66.18	.	1.43E+00	.
4745	68.88	.	1.48E+00	.
5110	71.48	.	1.53E+00	.
5475	73.99	.	1.57E+00	.
5840	76.42	.	1.62E+00	.
6205	78.77	.	1.66E+00	.
6570	81.06	.	1.70E+00	.
6935	83.28	.	1.74E+00	.
7300	85.44	.	1.78E+00	.

Data are not corrected for radioactive decay

Table 11-3

Predicted and Actual Releases from PEROXIDE BICARBONATE (PB) using Model 3

Matrix : PC-30 & BENTONITE
Waste form composition: 44 ml PB, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	4.06E-03	4.02E-03	4.39E-05
2	1.41	5.99E-03	6.06E-03	-6.94E-05
3	1.73	7.62E-03	7.63E-03	-1.20E-05
4	2.00	8.99E-03	8.95E-03	3.75E-05
7	2.65	1.18E-02	1.29E-02	-1.11E-03
14	3.74	1.46E-02	1.46E-02	-7.00E-05
21	4.58	1.65E-02	1.60E-02	5.18E-04
28	5.29	1.81E-02	1.71E-02	1.01E-03
80	8.94	2.33E-02	2.29E-02	3.64E-04
120	10.95	2.54E-02	2.62E-02	-7.10E-04
365	19.10	.	3.92E-02	.
730	27.02	.	5.18E-02	.
1095	33.09	.	6.15E-02	.
1460	38.21	.	6.96E-02	.
1825	42.72	.	7.68E-02	.
2190	46.80	.	8.33E-02	.
2555	50.55	.	8.93E-02	.
2920	54.04	.	9.49E-02	.
3285	57.31	.	1.00E-01	.
3650	60.42	.	1.05E-01	.
4015	63.36	.	1.10E-01	.
4380	66.18	.	1.14E-01	.
4745	68.88	.	1.19E-01	.
5110	71.48	.	1.23E-01	.
5475	73.99	.	1.27E-01	.
5840	76.42	.	1.31E-01	.
6205	78.77	.	1.34E-01	.
6570	81.06	.	1.38E-01	.
6935	83.28	.	1.42E-01	.
7300	85.44	.	1.45E-01	.

Data are not corrected for radioactive decay

Table 12-3

Predicted and Actual Releases from PEROXIDE BICARBONATE (PB) using Model 3

Matrix : PC-30 & SILICATE
Waste form composition: 44 ml PB, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	1.38E-01	1.40E-01	-1.59E-03
2	1.41	1.86E-01	1.83E-01	2.18E-03
3	1.73	2.18E-01	2.17E-01	1.18E-03
4	2.00	2.43E-01	2.45E-01	-1.77E-03
7	2.65	2.90E-01	3.12E-01	-2.20E-02
14	3.74	3.35E-01	3.35E-01	2.30E-04
21	4.58	3.64E-01	3.53E-01	1.09E-02
28	5.29	3.86E-01	3.68E-01	1.76E-02
80	8.94	4.52E-01	4.47E-01	5.58E-03
120	10.95	4.77E-01	4.90E-01	-1.24E-02
365	19.10	.	6.64E-01	.
730	27.02	.	8.33E-01	.
1095	33.09	.	9.63E-01	.
1460	38.21	.	1.07E+00	.
1825	42.72	.	1.17E+00	.
2190	46.80	.	1.26E+00	.
2555	50.55	.	1.34E+00	.
2920	54.04	.	1.41E+00	.
3285	57.31	.	1.48E+00	.
3650	60.42	.	1.55E+00	.
4015	63.36	.	1.61E+00	.
4380	66.18	.	1.67E+00	.
4745	68.88	.	1.73E+00	.
5110	71.48	.	1.79E+00	.
5475	73.99	.	1.84E+00	.
5840	76.42	.	1.89E+00	.
6205	78.77	.	1.94E+00	.
6570	81.06	.	1.99E+00	.
6935	83.28	.	2.04E+00	.
7300	85.44	.	2.08E+00	.

Data are not corrected for radioactive decay

Table 13-3

Predicted and Actual Releases from POTASSIUM PERSULFATE (PP) using Model 3

Matrix : PORTLAND TYPE 30 CEMENT (PC-30)
Waste form composition: 70 ml PP AND 100 g PORTLAND TYPE 30 CEMENT

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.06E-01	2.08E-01	-1.95E-03
2	1.41	2.78E-01	2.75E-01	2.62E-03
3	1.73	3.29E-01	3.27E-01	1.55E-03
4	2.00	3.69E-01	3.71E-01	-2.22E-03
7	2.65	4.38E-01	4.77E-01	-3.85E-02
14	3.74	5.10E-01	5.10E-01	1.89E-04
21	4.58	5.55E-01	5.35E-01	1.99E-02
28	5.29	5.87E-01	5.56E-01	3.05E-02
80	8.94	6.76E-01	6.66E-01	9.41E-03
120	10.95	7.05E-01	7.27E-01	-2.15E-02
365	19.10	.	9.72E-01	.
730	27.02	.	1.21E+00	.
1095	33.09	.	1.39E+00	.
1460	38.21	.	1.55E+00	.
1825	42.72	.	1.68E+00	.
2190	46.80	.	1.81E+00	.
2555	50.55	.	1.92E+00	.
2920	54.04	.	2.02E+00	.
3285	57.31	.	2.12E+00	.
3650	60.42	.	2.22E+00	.
4015	63.36	.	2.31E+00	.
4380	66.18	.	2.39E+00	.
4745	68.88	.	2.47E+00	.
5110	71.48	.	2.55E+00	.
5475	73.99	.	2.63E+00	.
5840	76.42	.	2.70E+00	.
6205	78.77	.	2.77E+00	.
6570	81.06	.	2.84E+00	.
6935	83.28	.	2.90E+00	.
7300	85.44	.	2.97E+00	.

Data are not corrected for radioactive decay

Table 14-3

Predicted and Actual Releases from POTASSIUM PERSULFATE (PP) using Model 3

Matrix : PC-30 & BENTONITE

Waste form composition: 70 ml PP, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	3.88E-02	3.76E-02	1.23E-03
2	1.41	4.86E-02	5.05E-02	-1.96E-03
3	1.73	6.01E-02	6.04E-02	-3.21E-04
4	2.00	6.98E-02	6.87E-02	1.05E-03
7	2.65	8.74E-02	9.61E-02	-8.67E-03
14	3.74	1.05E-01	1.06E-01	-5.18E-04
21	4.58	1.17E-01	1.13E-01	4.37E-03
28	5.29	1.27E-01	1.19E-01	7.79E-03
80	8.94	1.52E-01	1.50E-01	1.90E-03
120	10.95	1.63E-01	1.68E-01	-4.87E-03
365	19.10	.	2.36E-01	.
730	27.02	.	3.06E-01	.
1095	33.09	.	3.59E-01	.
1460	38.21	.	4.03E-01	.
1825	42.72	.	4.42E-01	.
2190	46.80	.	4.77E-01	.
2555	50.55	.	5.09E-01	.
2920	54.04	.	5.39E-01	.
3285	57.31	.	5.67E-01	.
3650	60.42	.	5.94E-01	.
4015	63.36	.	6.20E-01	.
4380	66.18	.	6.44E-01	.
4745	68.88	.	6.67E-01	.
5110	71.48	.	6.90E-01	.
5475	73.99	.	7.11E-01	.
5840	76.42	.	7.32E-01	.
6205	78.77	.	7.52E-01	.
6570	81.06	.	7.72E-01	.
6935	83.28	.	7.91E-01	.
7300	85.44	.	8.10E-01	.

Data are not corrected for radioactive decay

Table 15-3

Predicted and Actual Releases from POTASSIUM PERSULFATE (PP) using Model 3

Matrix : PC-30 & SILICATE
Waste form composition: 70 ml PP, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

Time (DAYS)	SQRT Time	Actual Cumulative Fraction (cm)	Predicted Cumulative Fraction (cm)	Residual (cm)
1	1.00	2.08E-01	2.10E-01	-2.38E-03
2	1.41	2.79E-01	2.76E-01	3.14E-03
3	1.73	3.28E-01	3.26E-01	2.01E-03
4	2.00	3.66E-01	3.69E-01	-2.77E-03
7	2.65	4.29E-01	4.64E-01	-3.47E-02
14	3.74	5.04E-01	5.02E-01	1.72E-03
21	4.58	5.51E-01	5.32E-01	1.85E-02
28	5.29	5.84E-01	5.57E-01	2.67E-02
80	8.94	6.89E-01	6.86E-01	3.53E-03
120	10.95	7.41E-01	7.57E-01	-1.57E-02
365	19.10	.	1.04E+00	.
730	27.02	.	1.32E+00	.
1095	33.09	.	1.54E+00	.
1460	38.21	.	1.72E+00	.
1825	42.72	.	1.88E+00	.
2190	46.80	.	2.02E+00	.
2555	50.55	.	2.15E+00	.
2920	54.04	.	2.28E+00	.
3285	57.31	.	2.39E+00	.
3650	60.42	.	2.50E+00	.
4015	63.36	.	2.60E+00	.
4380	66.18	.	2.70E+00	.
4745	68.88	.	2.80E+00	.
5110	71.48	.	2.89E+00	.
5475	73.99	.	2.98E+00	.
5840	76.42	.	3.06E+00	.
6205	78.77	.	3.15E+00	.
6570	81.06	.	3.23E+00	.
6935	83.28	.	3.31E+00	.
7300	85.44	.	3.38E+00	.

Data are not corrected for radioactive decay

APPENDIX 11

FIGURE 1-3

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 3

WASTE=ALKALINE PERMANGANATE (AP)

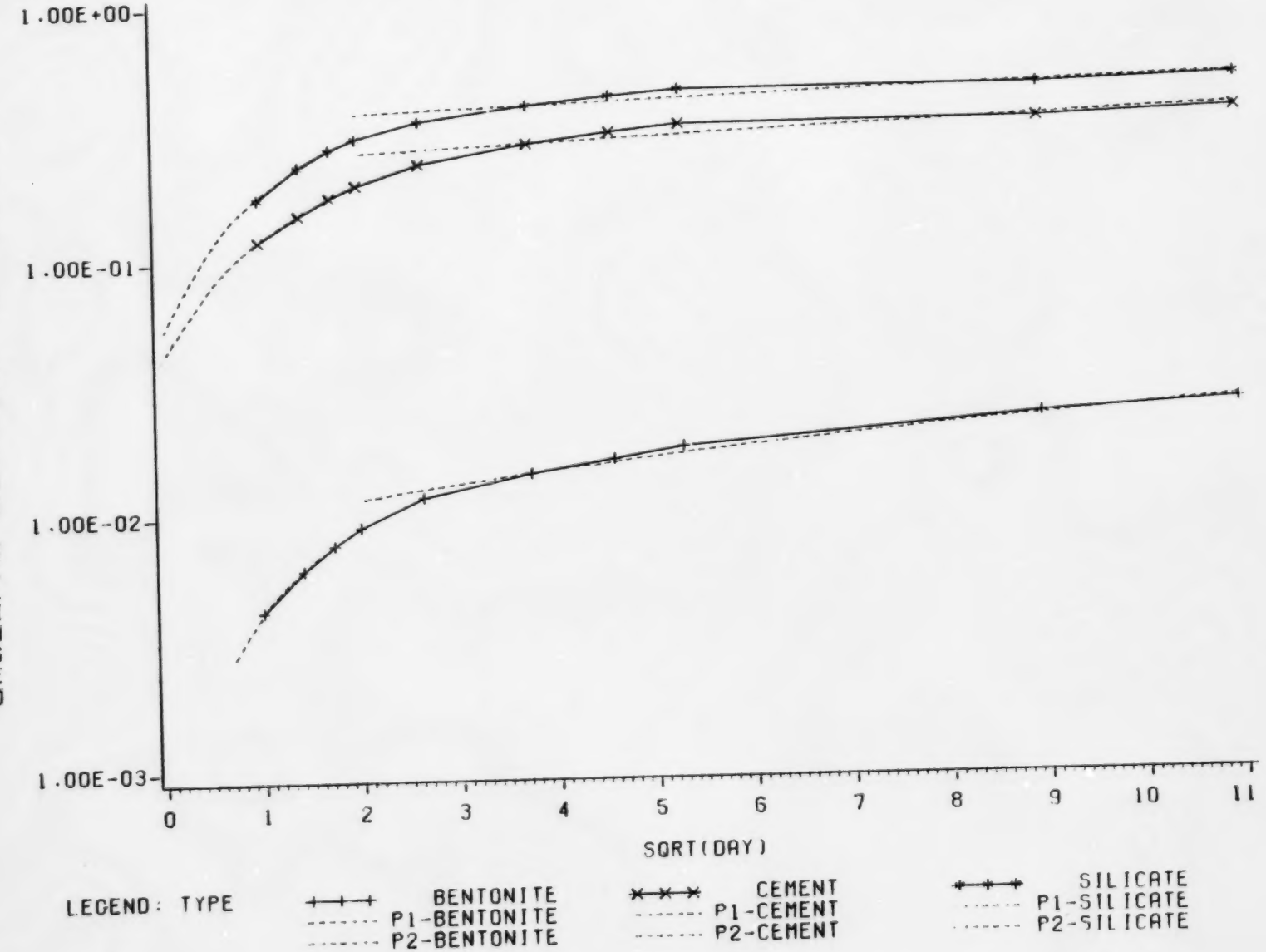
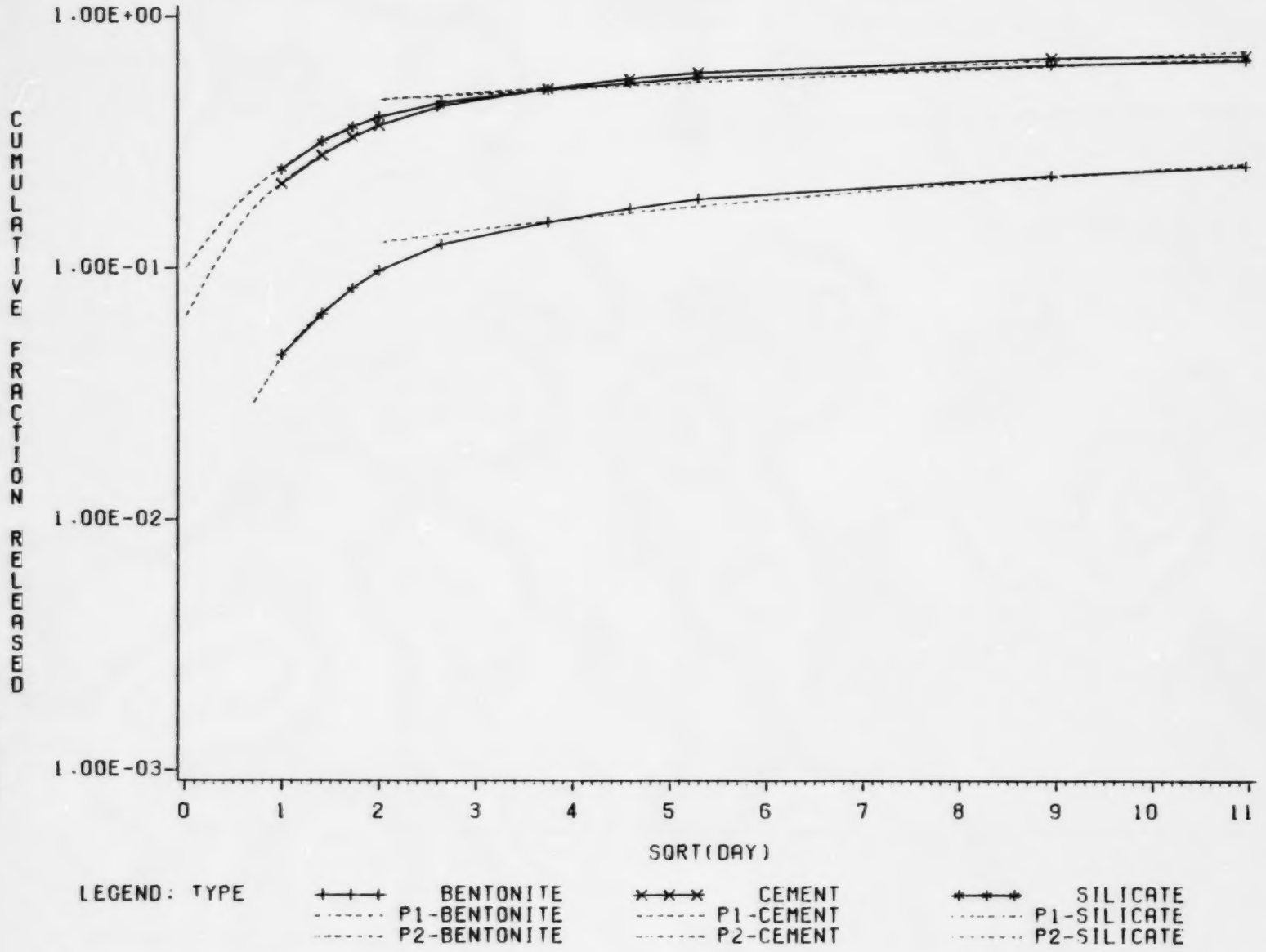


FIGURE 2-3

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 3
WASTE=TURCO 4512



84-209

FIGURE 3-3

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 3
WASTE=TURCO 4521A

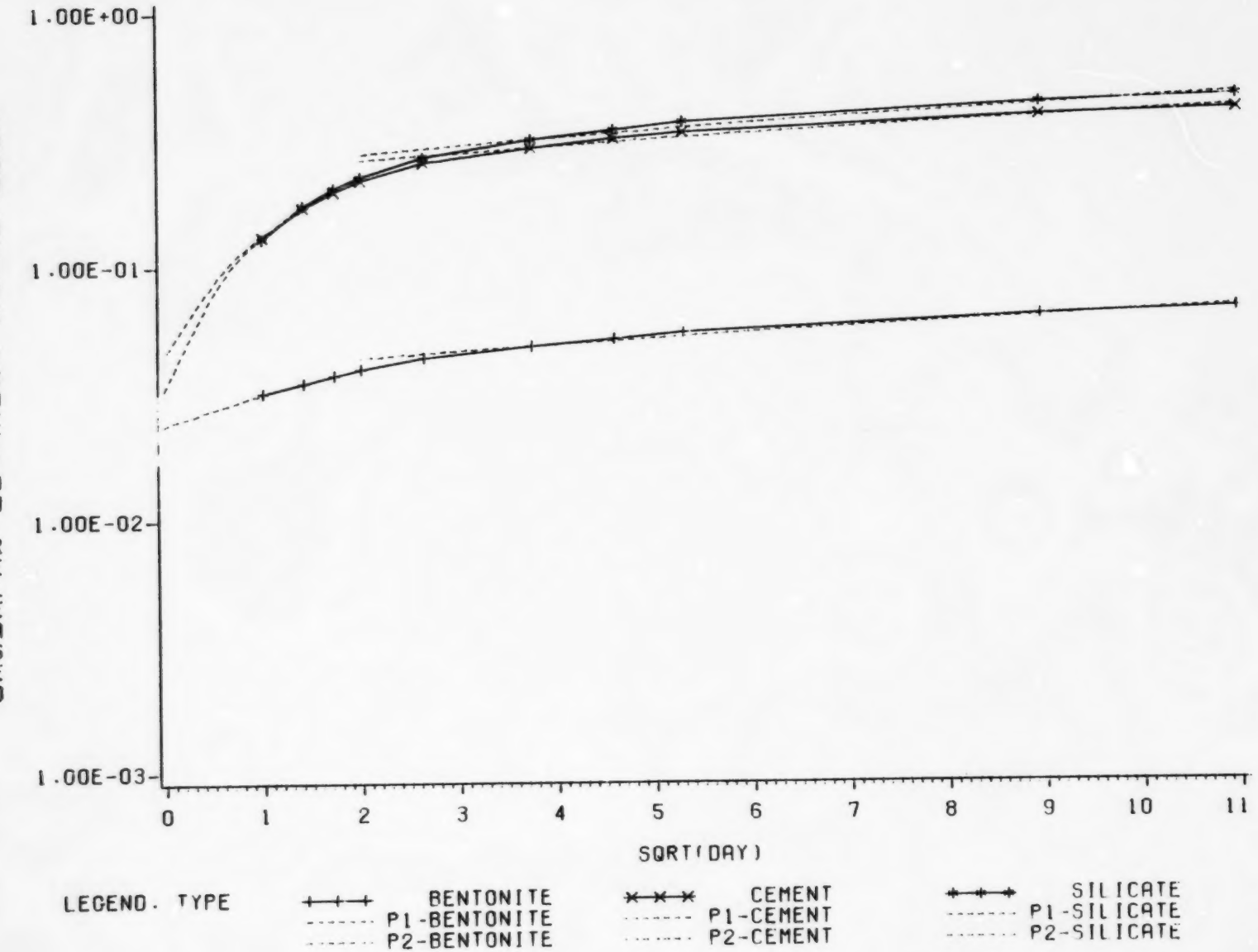


FIGURE 4-3

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 3
WASTE=POTASSIUM PERSULFATE (PP)

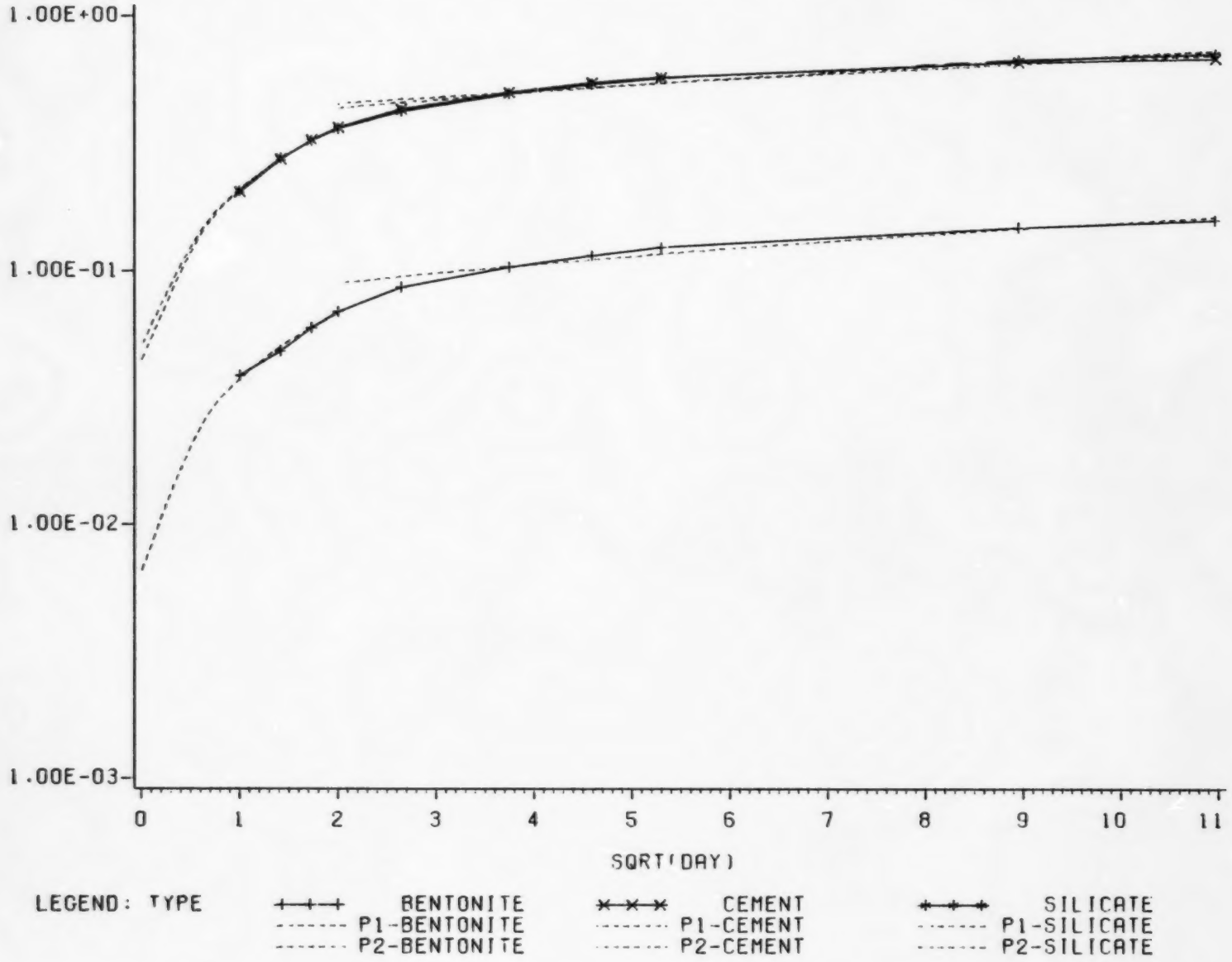


FIGURE 5-3

PREDICTED AND ACTUAL RELEASES FROM CEMENTED DECONTAMINATION WASTES

MODEL 3

WASTE=PEROXIDE BICARBONATE (PB)